PALEOETHNOBOTANY IN INTERIOR ALASKA

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A

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Abstract

Vegetation and plant resources can impact forager mobility and subsistence strategies. However, misconceptions about the preservation of organics in subarctic archaeological contexts and underestimations of the importance of plant resources to foraging societies limit paleoethnobotanical research in high-latitude environments. This research draws upon concepts from human behavioral ecology to address questions relating to site seasonality, plant resource use, land use, and deposition and taphonomy. The model developed in this thesis outlines expectations of seasonal archaeobotanical assemblages for Late Pleistocene and Holocene sites in interior Alaska. I consider these expectations in light of plant macroremains found in anthropogenic features from Components 1 and 3 (approximately 13,300 and 11,500 cal yr BP, respectively) at the Upward Sun River site, located in central Alaska.

Site-specific methods include bulk sampling of feature matrix in the field and wet-sieving matrix in the laboratory to collect organic remains. Analytical measures of density, diversity, and ubiquity tie together the model expectations and the results from Upward Sun River. The dominance of common bearberry in the Component 1 archaeobotanical assemblage meets the expectations of a late summer or fall occupation. This suggests that site occupants may have focused on mitigating the risk of starvation in winter months by foraging for seasonally predictable and storable resources. The variability in results from the Component 3 features could relate to longer-term occupations that extended from mid-summer to early fall, in which site occupants foraged for locally available and predictable plant resources such as blueberry or low-bush cranberry species.

In this thesis, I argue that large mammal resources were a key component in Late Pleistocene and Holocene subsistence strategies. However, foragers were flexible in their behavior and also targeted small mammals, fish, waterfowl, and plant resources in response to environmental conditions and cultural preferences. The results illustrate the long-standing use of culturally and economically important plant resources in interior Alaska and draw attention to aspects of human behavior that are under-conceptualized in northern archaeology, such as the gender division of labor, domestic behavior, and potential impacts of plant resource exploitation on mobility and land use.

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Chapter 1

Archaeobotany in High-Latitude North America

Past and present interactions between humans and the environment are a popular topic of research in northern North America. Recent studies emphasize change in the modern environment and associated influences on mixed subsistence-cash economies in northern communities (Hinzman et al. 2005; Kofinas et al. 2010; Moerlein and Carothers 2012). Northern archaeologists and paleoecologists explore the influence of environmental change on humans and other organisms and address the impacts that humans can have on the environment over broad temporal scales (Bigelow and Powers 2001; Guthrie 2006; Mason and Bigelow 2008; Mason et al. 2001; Thorson 1990). In this research, I addresses human-environment interaction by examining macrobotanical remains found in cultural features from multiple components at the Upward Sun River site (XBD-298) in the Tanana River basin, dating between 13,300 and 9000 calibrated years before present (Potter et al. 2011a, 2014).

Although paleoecological studies in Alaska and other high-latitude regions often include macrobotanical remains, misconceptions regarding the preservation of plants and their significance to foraging societies have led to a lack of attention for these archaeological remains (Lepofsky et al. 2001). However, plants often serve as supplements to meat-oriented diets, offer nutrients not found in other foods, provide raw materials for structures and tools, and influence mobility (Kuhnlein and Turner 1991). In this thesis, I highlight the importance of archaeobotanical datasets for addressing questions of prehistoric subsistence and settlement practices for Late Pleistocene and Holocene northern environments.

This chapter introduces key concepts and terminology related to archaeobotany and archaeology in high-latitude North America and discusses the importance of research at the Upward Sun River site. The first sections summarize the current state of archaeobotanical research in high-latitude environments, biases in our understanding of foraging behavior in these regions, and the role that research at the Upward Sun River site can play in mitigating these biases. The final section in this chapter outlines the objectives, questions, and organization of this thesis.

1.1 Introduction

The term archaeobotany refers to the recovery and identification of plants at archaeological sites. Alternatively, paleoethnobotany refers to the theoretical framework applied when making broader interpretations of plant remains and their use by human occupants at archaeological sites (Ford 1979; Miller 1997). Although there is some distinction between the terms, I use archaeobotany and paleoethnobotany interchangeably. Some archaeologists apply paleobotany with the same meaning, although specialists reserve this term for the study of plant materials from deposits that are not associated with human activity (Fritz 2005).

Archaeobotanical research deals with a variety of preserved plant remains, such as microremains, macroremains, and residues (Birks 2007; Ford 1979; Miller 1997; Pearsall 2000). Microremains are microscopic plant remains such as pollen, spores, and phytoliths. Plants can also leave traces of residue in soil or on artifacts such as cooking and storage containers. Macrobotanical remains are the small, hardy portions of plants that are typically visible to the naked eye. Materials in this category include wood, nuts, needles, seeds, fruit pips, and artifacts made from plants, such as baskets and mats. Archaeobotanists often refer to macrobotanical remains as plant macrofossils, though these remains usually are not fossilized in archaeological contexts (Birks 2007; Fritz 2005; Pearsall 2000).

Biases and misconceptions limit archaeobotanical studies in northern contexts, though the research that does occur often focuses on the relationships between environmental and human systems (Crawford 2012; Deal 2005; Lepofsky et al. 1996; Lepofsky and Lyons 2003; Potter 2005; Wollstonecroft 2002; Zutter 2009). Throughout this thesis, the term environment encompasses geography, climate, ecology, and geology as inter-related and connected systems. In addition, the term high-latitude refers to the Subarctic (50 and 66°N) and the Arctic (north of the Arctic Circle at approximately 66°N). On a broad-scale, this research focuses on human-environment interactions that occurred throughout the Late Pleistocene and Holocene in interior Alaska.

When mentioned throughout this thesis, the term Beringia (Figure 1.1) refers to the landmass extending west to the Lena River in Siberia and east to the Mackenzie River in Canada (Hoffecker and Elias 2007). This land bridge connected Siberia and North America throughout a period of lower global sea level (around 120 m below modern) during the Last Glacial Maximum and Late Glacial period of the Late Wisconsinan Glaciation, around 25,000 to 13,000 calibrated

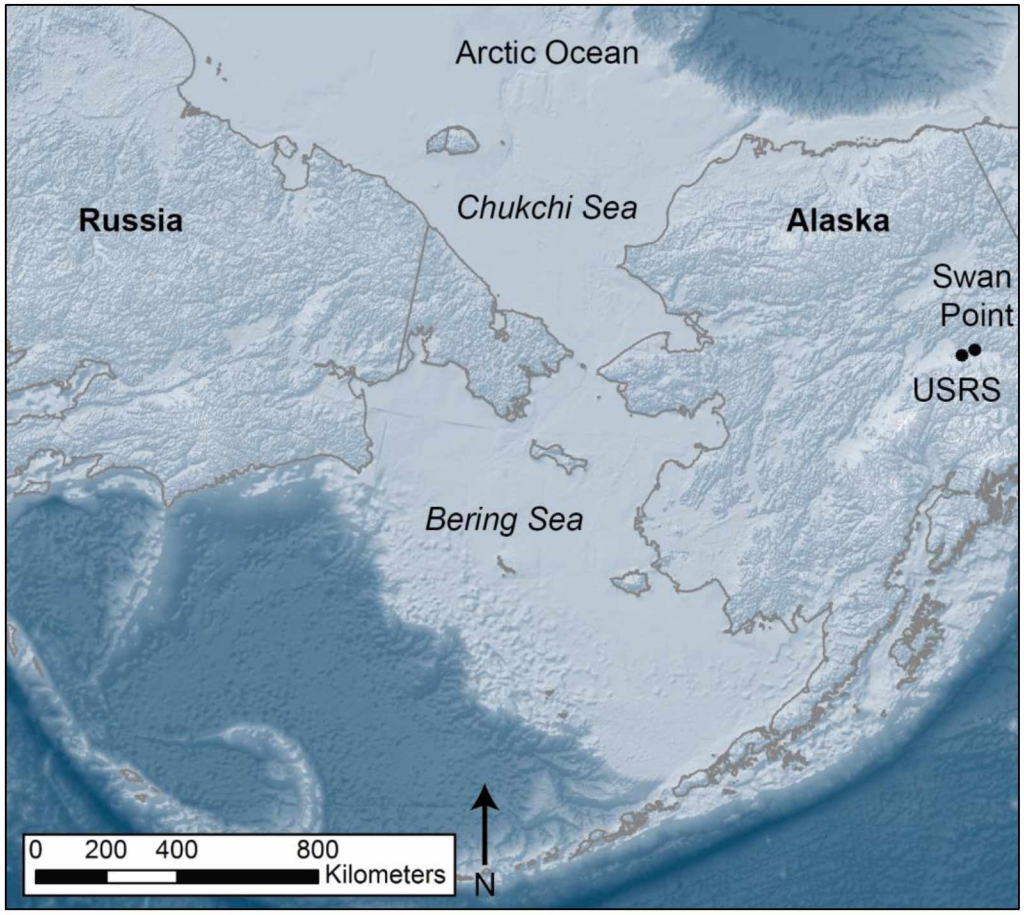

Figure 1.1 Beringia. This map illustrates regions that were exposed due to lower global sea levels (the lighter regions between Russia and Alaska) during the Last Glacial Maximum. This resulted in a connection between the two continents termed the Bering Land Bridge or Beringia. The map also highlights the location of Swan Point, which contains the oldest evidence of human occupation in Alaska, and Upward Sun River (USRS), which is the focus of this research.

years before present (Dyke et al. 2002). Unless otherwise noted, I present dates as calibrated years before present (cal yr BP) using Calib 7.1 calibration software with IntCal 13 for consistency and comparison (Reimer et al. 2013).

By the Late Pleistocene, human populations had migrated across the Bering Land Bridge into the New World (Goebel et al. 2008). Climatic amelioration during the Early Holocene led to the inundation of the land bridge. In particular, this research addresses the influence that Late Pleistocene and Holocene environmental changes had on plant and animal resource availability and associated shifts in human subsistence and settlement practices in interior Alaska. Analysis of archaeobotanical evidence from Upward Sun River Components 1 (13,300-13,120 cal yr BP)

and 3 (11,610-11,280 cal yr BP) can inform on local response to broad-scale climate change during these periods. However, this research contends with several biases in high-latitude archaeology that limit our understanding of foraging behavior in interior Alaska.

1.1.1 Biases in High-Latitude Archaeology

When studying resource exploitation in the archaeological record, researchers generally focus on lithic and faunal datasets (Ford 1979; Lepofsky et al. 2001). There are a number of reasons for the emphasis on lithic and faunal over floral datasets. One major factor is taphonomic bias; in general, lithic remains and large mammal bones preserve better in the archaeological record than small mammal bones and plant remains (Speth 2010). An additional factor includes the influence of early ethnographies on archaeological theory. Male ethnographers studying foraging populations frequently focused on men's contribution to the diet and associated material culture, which often included large mammals and hunting equipment, respectively (Speth 2010). Furthermore, western medicine over-emphasizes the importance of animal protein as the main nutrient necessary to sustain health (Speth 2010).

In Alaska, archaeology has a long-standing relationship with the culture-history theoretical approach. Until recently, research predominately focused on the development of regional cultural chronologies and stone tool typologies (Cook 1969; Powers and Hoffecker 1989; Rainey 1940; West 1967), often to the exclusion of zooarchaeological and archaeobotanical datasets. When compounded with broader biases within the discipline of archaeology, misconceptions in Alaskan archaeology ultimately lead to an over-emphasis on big game hunting and men's foraging behavior. Taphonomic and theoretical problems are difficult to address. For example, an archaeologist cannot determine which artifacts preserve in the record and in many cases male ethnographers were denied access to communication with women in foraging communities. However, acknowledging these biases and incorporating multiple lines of evidence into archaeological research can strengthen interpretations of prehistoric behavior.

Archaeobotanical analysis is usually an afterthought in archaeological research and often only occurs when plant remains are encountered in the laboratory. This means that specialists have to deal with limited samples and a lack of contextual information (Lepofsky et al. 2001). This impacts the inferences that researchers can make about such assemblages and creates problems when integrating archaeobotanical information with other lines of evidence (Lepofsky

et al. 2001). Ideally, archaeobotanists should examine the context of a site before and during excavation to decide on appropriate sampling strategies in the field and laboratory methods for analysis.

Archaeobotanical and zooarchaeological research at well-stratified sites in interior Alaska can lessen some misconceptions and biases in high-latitude archaeology. In particular, the exceptional preservation and the unique context of the archaeological remains at Upward Sun River offer an opportunity to study aspects of prehistoric foraging behavior that are generally neglected in Alaskan archaeology. The site contains evidence of a semi-subterranean residential structure associated with an approximately 11,500 cal yr BP child cremation and double infant burial (Potter et al. 2011a, 2014). In addition, the zooarchaeological assemblage suggests a wide diet breadth dominated by small mammals, waterfowl, and salmon (Potter et al. 2011a, 2014). These data highlight aspects of domestic behavior that researchers miss when studying lithic or faunal datasets obtained from short-term hunting camps (Potter et al. 2011a).

1.2 Research Design

In this thesis, human behavioral ecology serves as a theoretical framework to examine human-environment interaction in northern North America. The broad-scale objective of this research is to explore the relationship between plant resources and foraging behavior in interior Alaska and to address some of the biases in high-latitude archaeology. This research has several specific objectives. The first is to identify macrobotanical remains and explain patterns in the data within and between features and components at the Upward Sun River site. The second objective is to obtain AMS radiocarbon dates directly from archaeobotanical samples of culturally and ecologically significant taxa to establish their presence in the Tanana River basin during the Late Pleistocene and Early Holocene. Several questions guide this research.

1.2.1 Research Questions

In this research, I draw upon concepts from human behavioral ecology to develop a model of expectations of seasonal archaeobotanical assemblage characteristics (i.e., content, density, diversity, and ubiquity) for Late Pleistocene and Holocene occupations in interior Alaska. Although Upward Sun River Components 1 (13,300-13,120 cal yr BP) and 3 (11,610-11,280 cal yr BP) date to the Late Pleistocene and the transition to the Early Holocene, I also

consider Middle and Late Holocene occupation in interior Alaska for comparative purposes. Archaeological and paleoenvironmental records, in addition to ethnographic and contemporary records of plant resource use, provide contextual information for model development. The model aims to address research questions related to four broad themes. These include: plant deposition and taphonomy, site seasonality, plant resource use, and human land use.

- *Deposition and Taphonomy*: Are natural and anthropogenic deposits of plant remains at an archaeological site distinguishable? What anthropogenic processes and activities lead to the deposition of plant remains at an archaeological site? What processes have impacted plant remains at the Upward Sun River site since deposition?
- *Site Seasonality*: What season of occupation does the archaeobotanical assemblage indicate? How does this compare with other lines of evidence? How could seasonal differences in foraging behavior impact archaeobotanical assemblage content?
- *Resource Use*: How were plant resources used by site inhabitants? What does the diversity of edible and medicinal plants suggest about diet breadth? Do edible and medicinal plants provide nutrients not found in other foods?
- *Land Use*: Were identified plants available near the site during occupation? Or were site inhabitants traveling greater distances to procure plant resources? How can plant resource exploitation influence settlement location and mobility?

I apply standard paleoethnobotanical analyses to address these questions. In particular, measures of density, diversity and ubiquity tie together model expectations and archaeobotanical assemblage content at Upward Sun River. In addition, the archaeobotanical assemblage from the Gerstle River site (XMH-246), located in interior Alaska, serves as a comparative dataset for Upward Sun River (Potter 2005).

Chapter 2

Theory, Methods, and Taphonomy

This thesis considers questions relating to seasonality, plant resource use, land use, and deposition and taphonomy at regional- and site-specific scales. The first section in this chapter describes human behavioral ecology as the theoretical approach for the regional-scale analysis, with particular reference to optimal foraging and risk avoidance models of foraging behavior. In addition, I outline the procedure for developing the model of plant exploitation. The second section relays site-specific procedures for the recovery and analysis of macrobotanical remains from Upward Sun River and explains the reasons for choosing these methods. In the last section, I discuss the deposition and taphonomy of macrobotanical remains in northern environments and the influence that sampling strategies have on archaeobotanical assemblages. Comparisons of model results to the archaeobotanical assemblage from the Upward Sun River site can inform on site-specific foraging behavior and provide information for future use and refinement of the model against other macrobotanical datasets in the region.

2.1 Human Behavioral Ecology and Foraging Models

As a theoretical approach, human behavioral ecology addresses questions of adaptive and optimal behavior expressed in foraging and mating strategies within a hypothetico-deductive and neo-Darwinian framework (Bird and O'Connell 2006; Winterhalder and Smith 2000). The theory emerged out of evolutionary ecology in the 1960s and 1970s and borrows from concepts proposed in economics, decision theory, and operations research (Bird and O'Connell 2006; Borgerhoff Mulder and Schacht 2012; Winterhalder and Smith 2000). However, human behavioral ecology does not focus on the mechanics of natural selection and decision making (Borgerhoff Mulder and Schact 2012).

Human behavioral ecology takes a functional or adaptive stance and assumes that natural selection works on humans to allow them flexibility in behavior and response to environmental conditions. This allows humans to weigh the costs and benefits of particular choices and act in ways that enhance overall fitness (Borgerhoff Mulder and Schacht 2012; Kelly 2000; Smith 1983). The benefit of this framework is its ability to generate testable hypotheses about human behavior in a broad range of ecological conditions (Bettinger 1991; Broughton and O'Connell 1999; Kelly 2000; Nettle et al. 2013; Smith 1983).

Archaeobotanists often use human behavioral ecology as a theoretical approach to investigate plant remains at archaeological sites. Popular research topics include intensification of plant exploitation, the development of agriculture, as well as shifts in diet breadth, mobility, and settlement patterns (Barlow and Metcalfe 1996; Bonzani 1997; Elston and Zeanah 2002; Gremillion 2002, 2004; Weiss et al. 2004). In this thesis, human behavioral ecology functions as a theoretical framework to explore the relationship between plant resources and Late Pleistocene and Holocene foraging behavior in interior Alaska. When addressing questions related to subsistence and land use, archaeologists and anthropologists generally draw on a set of related foraging models, such as diet breadth, patch choice, central place foraging, and risk avoidance models.

Diet breadth models rank potential prey according to return rates (often measured in units of energy) to predict which resources a fitness-maximizing forager will exploit (MacArthur and Pianka 1966). In the hypothetical portrayal of the diet breadth model in Figure 2.1, the optimal decision is to procure the species that has the highest rank based on return rates, but is also the least costly in terms of search and handling time. The model assumes that foragers always exploit higher over lower ranked resources, with fluctuations in resource availability resulting in fluctuations in diet breadth (Broughton and O'Connell 1999; Smith 1983). For example, diet breadth broadens to include lower ranked resources if encounter rates for higher ranked resources decreases, whether due to over-exploitation or change in local ecology (Broughton and O'Connell 1999). On the other hand, increased dietary specialization occurs as high ranked resources become more abundant (Smith 1983).

The patch choice model addresses foraging behavior in an environment in which resources are grouped into patches (MacArthur and Pianka 1966). The Marginal Value Theorem relates to this model and suggests that returns in a patch diminish with more time spent foraging (Charnov 1976). The graphic illustration of the patch choice model in Figure 2.1 displays the point of maximum net gain before returns begin to decline for the patch. After this point, more time foraging is more costly in terms of energy expended in relation to the return rate of the resource. When returns diminish to the point where foraging in a new location is more efficient, the original patch is abandoned (Winterhalder 2001). As a set of patches becomes more productive, less time is spent in any one patch (Smith 1983).

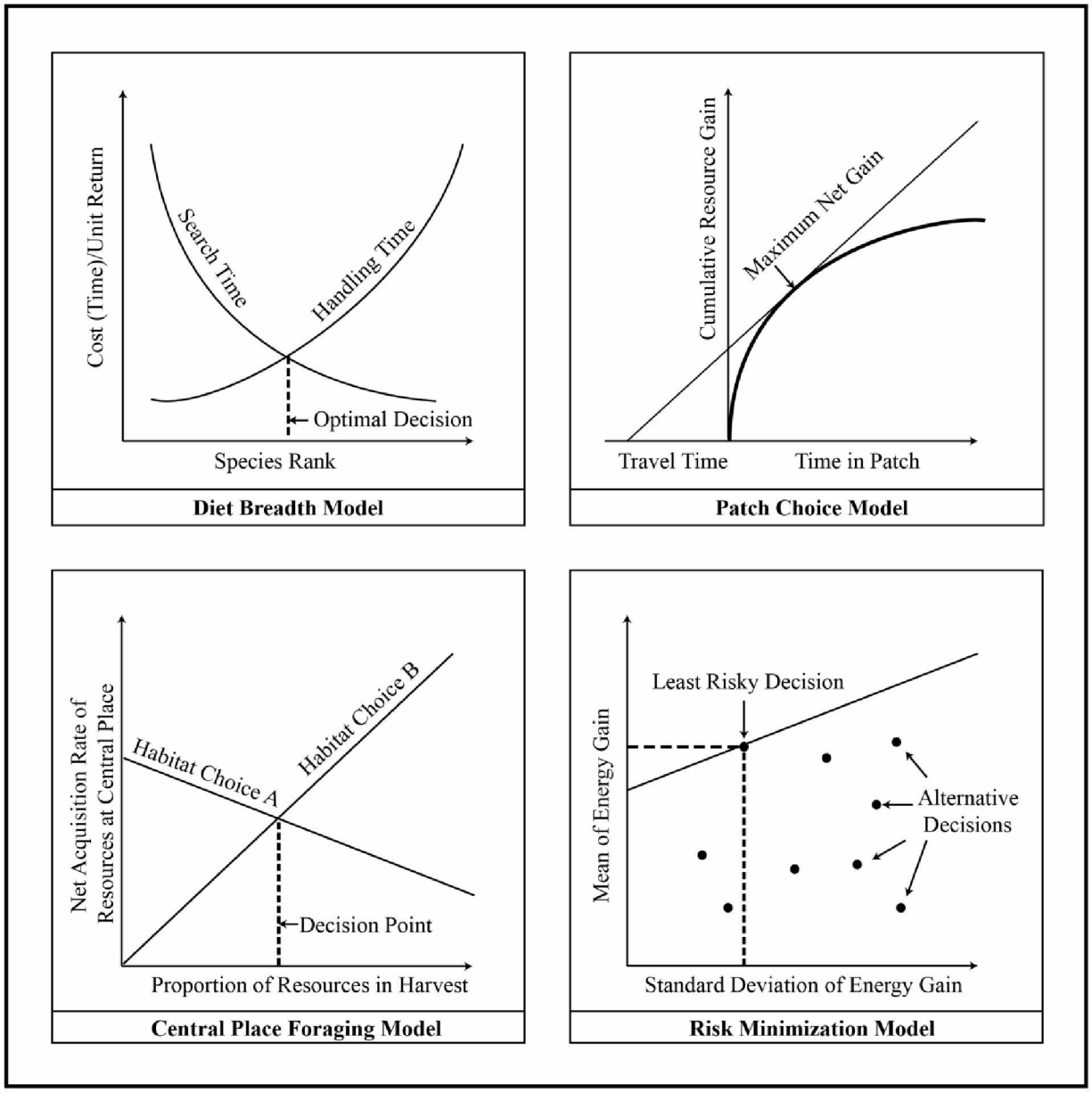

Figure 2.1 Foraging Models. These graphic illustrations represent the diet breadth, patch choice, central place foraging, and risk minimization models discussed in the main text. I adapted the figure from original versions in Bettinger et al. (2015), Kelly (2013), and Winterhalder (2001).

The central place foraging model considers hunting and gathering populations that consistently return to the same base camp after foraging (Orians and Pearson 1979). Important, difficult to transport, and less-frequently encountered resources determine the location of central base camps (Winterhalder 2001). How much an individual can carry, the energy and time that is required to do so, and the return rate of the resource influences field processing and transport decisions before bringing a resource from a foraging location back to the central camp (Bettinger et al. 1997; Bird and Bliege Bird 1997; Metcalfe and Barlow 1992; Wetterer 1989). Site occupants exploit the resources immediately surrounding a central place first and the rate at which they deplete available resources impacts decisions regarding the timing and frequency of camp movement (Winterhalder 2001).

The illustration for the central place foraging model in Figure 2.1 reflects a hypothetical decision between two potential habitats for a central base camp. Model expectations incorporate residential and logistical mobility proposed by Binford (1980) to gain a fuller understanding of how foraging behavior can influence land use strategies. Binford (1980) proposes a continuum of mobility strategies dependent upon resource availability. Residentially mobile groups move to the resource, while logistically mobile groups establish a base camp, from which task-specific groups disperse to obtain a resource and bring it back to the base camp (Binford 1980).

In the Figure 2.1 example, originally proposed by Winterhalder (2001), the optimal decision depends on the proportion of resources in the diet. If both habitats are identical, then the optimal choice is to settle in Habitat B and only harvest Habitat B resources. However, if both habitats contain different resources, then the optimal decision is to establish a base camp at Habitat B because it contains a greater proportion of resources in the diet and logistical task groups could procure resources from Habitat A. Bettinger et al. (1997) also combine central place foraging and concepts of residential and logistical mobility. They propose that if resource procurement occurs within the foraging radius of a residential camp, it is less costly than logistical procurement of the same resource. Greater residential mobility allows foragers to map on to seasonally important resources (Bettinger et al. 1997). Alternatively, logistically mobile groups organize base camps around locations with multiple resources, from which logistical procurement of less important resources occurs (Bettinger et al. 1997).

Caraco et al. (1980) introduce the concept of risk sensitivity in animal foraging behavior. In this context, risk refers to the probability of starvation. When considering the impact of risk on foraging behavior, biologists analyze the decision making process through *Z*-score modeling (Stephens 1981; Stephens and Charnov 1982). Anthropologists borrow from these studies to address the impact of risk on human foraging decisions (Bettinger 1991; Winterhalder et al. 1999). *Z*-score models assume that each foraging choice has a mean or expected value, with variation occurring around the mean (Winterhalder 1990). The choice is which resource to procure, with the net acquisition rate measured as units of energy. Fluctuation in resource availability or encounter rates produces variability in the net acquisition rate. For each choice available to a forager, a normal distribution for the net acquisition rate is assumed, with an expected mean and standard deviation. The researcher defines a minimum accepted threshold, often representing a point of starvation, and the risk is the chance of the net acquisition rate falling below this threshold (Winterhalder 1990). The standard normal deviation, or *Z*, measures risk and the optimal decision minimizes this value (Winterhalder 1990). Figure 2.1 portrays a graphic illustration of options available to a risk minimizing forager. The optimal choice minimizes the standard deviation of energy gain, while maximizing the mean energy gain.

In this research, I do not directly test these foraging models, although I draw on concepts introduced in human behavioral ecology as heuristic tools to establish expectations of plant resource use by Late Pleistocene and Holocene foragers in interior Alaska. The main concepts that guide the model expectations are optimal foraging and risk avoidance. The biases in archaeological research introduced in Chapter 1 carry over into foraging models. In these models, archaeologists emphasize the importance of caloric, fat, and protein intake derived from animal resources (Speth 2010). Although access to macro-nutrients impacts individual fitness, micro-nutrients also influence healthy cognitive and physiological functions (NAS 2011). Micro-nutrients are nutrients that the body needs in small amounts (mg) so that it can function properly, including vitamins, minerals, and organic acids (NAS 2011). The body requires greater amounts (g) of macro-nutrients, such as proteins, carbohydrates, and fats. To address this gap in the theory of human behavioral ecology, I emphasize alternate aspects of optimal foraging and risk avoidance models and consider the impact of plant resource exploitation on subsistence and land use strategies.

2.1.1 Procedures for Model Development

Reconstructing the importance of plant resources to the diets of prehistoric foragers is not straight-forward. This process requires two basic lines of evidence: the amount of a resource used and the nutritional value of the resource (Kuhnlein and Turner 1991). There is no way to directly reconstruct the abundance of plant resources on a prehistoric landscape. Raw counts of an archaeobotanical assemblage cannot serve as a direct reflection of the contribution of plant foods to prehistoric diets. Given the assumption that the nutritional contents of taxa are the same or similar to their modern day values, I establish inferences regarding the importance of plant resources to Late Pleistocene and Holocene foraging behavior from a nutritional standpoint.

Developing the model of plant resource exploitation in interior Alaska required several steps. First, I compiled a single database of ethnographic and modern accounts of wild-plant and game use in the North American Arctic and Subarctic. A major assumption associated with this model is that modern species ranges in northern environments are similar to those that existed in the past, unless paleoecological data suggest otherwise. After refining the database to include only species with modern ranges in interior Alaska, I compared it to sources of nutritional information (Kuhnlein and Turner 1991; Nobmann 1993; USDA 2015). Appendix A presents the nutritional data for plant taxa (Table A.1), animal taxa (Tables A.2-A.14), and recommended daily intakes for micro- and macro-nutrients (Table A.15). Rather than complicating the model with a ranking system for edible plant taxa based on nutrients, I considered these data relative to recommended daily requirements (NAS 2011).

Modern environmental, paleoenvironmental, and archaeological datasets provided context for the model developed in this thesis. Models of foraging behavior and land use inform on seasonal variation in animal resource availability that may have occurred during the Late Pleistocene and throughout the Holocene (Glassburn 2015; Holmes 2001; Potter 2007, 2008a, 2008b; Potter et al. 2013; Powers et al. 1983; Yesner 1996, 2001, 2007). In Chapter 3, I discuss these datasets and expand on the influence that seasonal fluctuation and broad-scale changes in the environment had on plant species distribution, resource availability, and foraging behavior. Consideration of depositional and taphonomic biases for interior Alaska helped to refine model expectations for archaeobotanical assemblage characteristics.

While the function of a plant resource undoubtedly influenced the decision-making process when foraging, foraging models generally address questions related to subsistence and

assume food as the standardized variable that impacts foraging decision-making. Rather than limit discussion to subsistence practices alone, I incorporated plant resource function into the model with reference to ethnographic and ice-patch archaeological data (Alix et al. 2012; Hare et al. 2004, 2012; VanderHoek et al. 2012). Artifacts found melting out of alpine ice-patches in the Yukon and Alaska offer a unique opportunity to study the use of organic technologies that often do not preserve in the archaeological record and inform on the selection of plant resources for functional implements (Alix et al. 2012; Hare et al. 2004, 2012; VanderHoek et al. 2012).

Appendix B presents the final database with reference information for plant and animal resources that made (and in many cases still make), important contributions to foraging behavior for archaeological, ethnographic, and modern populations. Due to fluctuations in seasonal availability of resources in high-latitude environments and the impact that this variability likely had on foraging behavior, I organized the model expectations into a seasonal framework with four seasons: spring (April and May), summer (June through August), fall (September through October), and winter (November through March). The final model is a compilation of plant and animal species that could appear in an interior Alaskan archaeological assemblage depending on site seasonality and associated foraging behavior. Although I attempted to avoid direct analogy between the ethnographic and archaeological records, the model expectations are influenced by ethnographic evidence. The next section discusses some of the problems associated with ethnographic analogy.

2.1.2 Problems Associated with Ethnographic Analogy

Although ethnographic records are important for understanding foraging lifeways, there are difficulties associated with relying heavily on ethnographic data to understand past behavior. This research uses ethnographic information when developing model expectations and discussing research implications in order to understand the range of behavior that can exist given specific environmental and cultural contexts. Chapter 3 discusses the discrepancies between the ethnographic record of Athabascan populations and the archaeological record for interior Alaska, though this section briefly summarizes these difficulties. In general, there are differences observed in the lifeways of Athabascan groups recorded in the ethnographic record and subsistence and settlement practices inferred from the archaeological record.

For example, ethnographic and ethnohistoric records suggest that moose hunting was crucial to Northern Athabascan subsistence strategies, although analysis of the zooarchaeological record from interior Alaskan sites suggest that this focus only developed recently (Yesner 1989). Caribou dominate zooarchaeological assemblages, suggesting that they were more important in Late Holocene subsistence strategies. In addition, recent research of inter-assemblage variability in the archaeological record for interior Alaska suggests changes in subsistence and land use strategies around 6000 and 1000 cal yr BP (Potter 2008a, 2008b). It is necessary to consider the marked difference between the ethnographic and archaeological records when exploring prehistoric foraging behavior.

In this research, several steps mitigate the difficulties associated with the use of ethnographic data. First, the range of plant resources incorporated into the final database includes both ethnographic and modern records from the North American Arctic and Subarctic. Limiting the dataset to interior Alaskan ethnobotanical data alone would create a bias in model expectations in favor of species used by ethnographic cultures in the region. Instead, the database incorporated any species with a recorded use in the Arctic or Subarctic that were potentially present in interior Alaska during the Late Pleistocene and Holocene.

I also reviewed ice-patch archaeological data for comparison to the ethnographic record. These data indicate changes in technology and raw material use over time, with artifacts dating back to approximately 9,300 cal yr BP (Hare et al. 2012). Ice-patch evidence indicates fluctuation in preference for raw material choice over time and highlights the differences when compared to ethnographic records of raw material selection.

Previous models of subsistence and land use highlight the differences in the archaeological and ethnographic records. This model proposes expectations of plant resource exploitation for six periods: the Last Glacial Maximum (~25,000 to 14,000 cal yr BP), the Late Glacial (~14,000 to 13,000 cal yr BP), the Late Pleistocene to Early Holocene transition (~13,000-11,500 cal yr BP), the Early Holocene (~11,500-6000 cal yr BP), the Middle Holocene (~6000 to 1000 cal yr BP), and the Late Holocene (~1000 cal yr BP to present). The division of these periods is based changes in paleoenvironmental and archeological data (Anderson et al. 2004; Anderson and Brubaker 1993; Bigelow 2013; Holmes 2001; Potter 2008a, 2008b, 2011; Yesner 2001, 2007). The model considers the differences in the role of plant resources in subsistence and land use strategies during each period.

2.2 Site-Specific Methods

Previous research at the Upward Sun River site focused on topics such as technological change, economy, and subsistence that are addressed with analyses of lithic, faunal, and floral datasets (Halffman et al. 2015; Potter et al. 2007a, 2008, 2011a, 2014). These analyses provide multiple lines of evidence that can strengthen inferences established with archaeobotanical data. Gelvin-Reymiller completed macrobotanical identification for a Component 1 hearth feature (Potter et al. 2007a, 2008) and processed the Component 3 cremation feature. Although charcoal analysis was outside the scope of this research project, previous radiocarbon assays on charcoal specimens identified to the genus-level or greater contribute to our understanding of species presence on the landscape during the time that the site was occupied (Potter et al. 2011a, 2014).

Potter et al. (2007a, 2011a) describe the general excavation procedures for the Upward Sun River site. Site-specific procedures consisted of meter-block excavation, primarily with trowels, but with some skim shovels in known sterile areas. A site datum and sub-data were established. Metal stakes marked the site grid at the corners of each 1x1 m excavation unit. Arbitrary levels (10 cm) controlled for horizontal provenience and excavation in 50x50 cm quadrants in each excavation unit secured vertical provenience. Testing at the site established that the root mat was sterile, so excavators removed the root mat and searched through it by hand, but did not screen the material. Below the root mat, excavators dry screened all sediment through $^{1}/_{8}$ in mesh. A total station recorded three-point provenience on an X, Y, and Z grid for all artifacts and ecofacts found in-situ.

The site-specific methods used to recover and analyze the archaeobotanical assemblage from Upward Sun River are standard to the sub-discipline of paleoethnobotany. Field methods, sampling strategies, laboratory procedures, and analytical techniques follow those outlined in Birks (2001) and Pearsall (2000). Measures of density, diversity and ubiquity tie together model expectations and assemblage analysis. Paleoethnobotanists frequently use these methods in studies of diet breadth (Bonzani 1997; Gremillion 2002, 2004; Pearsall 1983). Following the discussion of site-specific methods, I outline the basics of macrobotanical deposition and taphonomy and explain the reasoning behind the chosen field, lab, and analytical methods. In addition, I describe the potential biases in the archaeobotanical assemblages that can result from these methods.

2.2.1 Field Methods and Sampling Strategies

Potter (2015, personal communication) defined 16 of 63 features found at the Upward Sun River site as hearths. Excavators identified these features through associated charcoal and oxidized sediments, as well as bone and lithic artifacts. Hearth features served as the primary focal point for macrobotanical sampling at the site, although the cremation pit and burial feature (Potter et al. 2011a, 2014) were also processed for botanical remains. While there is "feature bias" present in archaeobotanical sampling (Lennstrom and Hastorf 1995: 702), bulk sampling features was the best way to address the research questions and issues of preservation and contamination at the site.

When excavators uncovered a hearth feature in the field, they systematically collected all of the associated sediment and stored it in gallon-sized bags. Features were numbered consecutively based on the order and year in which they were excavated. For example, the ninth hearth feature uncovered in the 2013 field season was titled Feature 2013-9. Three-point provenience information was taken for the feature surface, outline, and bottom. In addition, three-point provenience was taken when excavators observed variation in feature stratigraphy.

In addition, bulk sediment samples originally taken for gastropod and phytolith analysis were processed as archaeobotanical control samples to compare cultural and non-cultural deposits of macrobotanical remains (Appendix C). Excavators gathered the control samples from the exposed walls of excavation units every 10 cm, beginning in the upper forest soil horizons and extending down into the lower loess deposits at the site (around 280 cm below the modern site surface). Site excavators collected additional samples in the lower loess deposits (around 160 to 280 cm below the modern site surface) from every 10 cm level in the specified quadrant (see Appendix C for provenience information). The sediment samples were stored in gallon-sized bags and associated provenience information was recorded. Figure 2.2 is a generalized diagram of macroremain content for the control samples.

2.2.2 Laboratory Procedures

Research questions, site context, and project funding constrain laboratory procedures. Carol Gelvin-Reymiller originally analyzed macrobotanical remains from several features at the Upward Sun River site (Potter et al. 2007a, 2008). Claire Alix from UAF and Owen Davis from the University of Arizona made additional identifications of charcoal (Potter et al. 2011a).

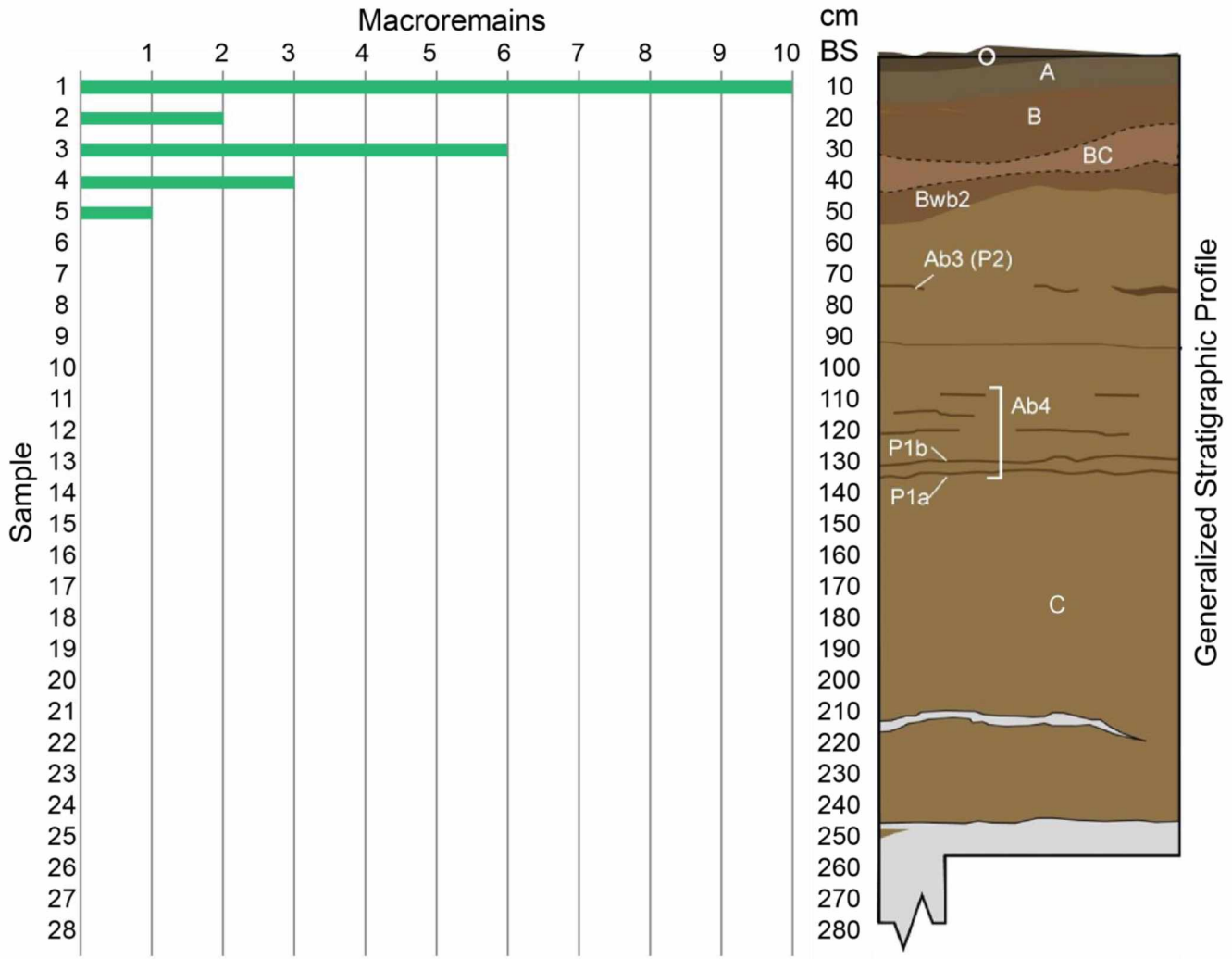

Figure 2.2 Control Samples. This illustration details the control sample macroremain count in relation to Upward Sun River stratigraphy. The upper forest soils (O, A, B, BC, and Bwb2) had the greatest density of macroremains, while the lower loess deposits, which contain the majority of the archaeology at the site, had no macroremains. I discuss the sampling procedure in greater detail in the main text and Appendix C details provenience information.

Gelvin-Reymiller conducted manual flotation on the entire matrix for Features 2010-1, 2010-2, and 2010-5 with procedures following Pearsall (1989). For flotation, the feature matrix was measured and submerged in a bucket bottomed with fine-mesh screen. After agitating the sample, the light fraction floats to the surface and the heavier fraction sinks to the bottom of the bucket, while fine sediments pass through the screen. Gelvin-Reymiller dried and examined the light and heavy fractions under a microscope (20x to 60x magnification; Potter et al. 2007a). Small artifacts such as bone fragments, lithics, and botanical remains were picked out of the flotation fractions and identified with reference materials.

For this research, I used wet-sieving methods to separate organic remains from feature matrix, as instructed by Dr. Nancy Bigelow from the Alaska Quaternary Center at the University of Alaska, Fairbanks. These standard paleoethnobotanical procedures follow those outlined in Birks (2001) and Pearsall (2000). After collecting samples from the field, I refrigerated or dried them in order to prevent microbial damage. In the laboratory, I subsampled and measured feature matrix with water displacement. For wet-sieving, I worked the subsample through geologic sieves of fining mesh sizes at 425, 250, and 125 microns (μm) with a gentle stream of water (Figure 2.3). In order to prevent contamination, I cleaned equipment after processing samples.

I observed separated plant remains in a petri-dish with a stereo-microscope to systematically separate materials with diagnostic features, with magnifications up to 20x typically sufficient to identify the smallest remains. I also separated lithic and faunal remains for future analysis, using small brushes and entomological forceps to separate remains without causing damage. I then sorted and identified botanical remains to the greatest taxonomic resolution possible with the help of reference collections and manuals housed at the UAF Alaska Quaternary Center laboratory. Once sorted and identified, I recorded the raw counts for later analysis and stored the macroremains in small vials with reverse-osmosis filtered water and refrigerated the samples at approximately 5°C in order to prevent decay.

An additional aim of this research was to directly date macrofossils of plant taxa that are under-represented in the pollen record and those that are difficult to identify to the species-level with pollen. For example, I identified seeds from the common bearberry and a species belonging to the blueberry or low-bush cranberry genus (*Vaccinium*) and sent the samples to Beta Analytic, Inc. for radiocarbon dating. These taxa belong to the taxonomic order of Ericales, which contains over 8000 plant species. Palynologists identified the presence of Ericales at sites such as Kaiyak

and Zagoskin Lake in Alaska and the Bluefish Exposure in the Yukon, dating to the Last Glacial Maximum (Bigelow 2013). However, identifying the pollen to the genus level or greater is difficult. The pollen record is useful identifying broad classifications of plant taxa on the landscape, though direct dating of plant macrofossils that are identified to the genus level or greater can establish the presence of culturally, economically, and ecologically significant resources. In Chapter 5, I present the results of radiocarbon dating and discuss the presence of key taxa in the Tanana River basin during the time that the Upward Sun River site was occupied.

Figure 2.3 Wet-Sieving System. This is a photo of the wet-sieving system discussed in the main text, with screens of fining mesh size (425, 250, and 125 μm). The hose was used to gently work sediment through the screen with reverse-osmosis filtered water.

2.2.3 Analytical Methods

In this research, I apply measures of density, diversity, and ubiquity to highlight trends in the archaeobotanical data and incorporate expectations of these measures into the model of Late Pleistocene and Holocene plant resource exploitation in interior Alaska. To account for differences in the total volume of feature matrix processed, archaeobotanists standardized the raw counts of the taxa. To standardize at the feature-scale, the total raw count of each taxon for one feature is divided by that feature's total volume of matrix processed. This value is then multiplied by the total volume of the smallest feature analyzed, resulting in the total concentration (or density, N) of a particular taxon per unit of matrix processed.

Diversity is a useful measure for paleoethnobotanical analysis. I apply the Shannon Weaver Diversity Index (Shannon and Weaver 1949) to the standardized archaeobotanical counts. The Shannon Weaver Index considers the richness, or the number of taxa per sample, and the evenness, or the abundance of taxa, of a sample. The result is a measure of diversity (*H'*) with higher numbers representing a more diverse community, lower numbers representing a less diverse community, and a value of 0 representing a community with one species.

In this analysis, I also calculate the ubiquity of plant taxa. Ubiquity is a percentage measure of the units (in this case, features) that contain a particular taxon (Pearsall 2000). Archaeobotanists apply ubiquity to evaluate the importance of specific taxa at a site without biasing inferences with raw counts, particularly when counts are low. There are problems with this approach, which include the tendency to over emphasize the importance of a particular taxon because it is present in many contexts, when in reality the raw count may suggest minimal contribution as a plant resource (Pearsall 2000). I acknowledge these problems and consider them when making inferences based on ubiquity.

It is important to note that plant macroremain abundance is not a direct measure of plant abundance. The absence of a particular taxon in an assemblage does not mean it was absent in the original plant community (Birks 2007; Dieffenbacher-Krall 2007). The archaeobotanical assemblage from Gerstle River (processed and identified by Gelvin-Reymiller; Potter 2005) serves as a comparative dataset for the Upward Sun River site to assess model expectations, identify aspects of the model that need clarification or adjustment, and determine the usefulness of the model for addressing plant-related subsistence practices in Late Pleistocene and Early Holocene interior Alaska.

Consistent sampling strategies and preservation at Upward Sun River and Gerstle River make inter- and intra-site comparisons possible (Potter 2005; Potter et al. 2007a, 2011b, 2014). In addition, Gelvin-Reymiller applied the same flotation procedures on the features at Gerstle River and those processed at Upward Sun River (Potter 2005; Potter et al 2007a). The similarity in the archaeobotanical assemblages resulting from the flotation and wet-sieved features suggests that inter-site comparison is appropriate. In the following section, I discuss the role of deposition and taphonomy in deciding site-specific methods and the biases that can result from different archaeobotanical sampling procedures.

2.3 Macrobotanical Deposition and Taphonomy

Past and present environments impact the preservation and recovery potential of organic remains. In addition, human behavior dictates which plant portions are deposited and the context in which they are preserved. In an archaeological context, taphonomy seeks to understand these processes. Archaeobotanical assemblages are subject to a number of taphonomic processes relating to deposition, preservation, sampling strategies in the field, subsampling in the laboratory, and the methods of recovery from sediment matrix.

The preservation of plant remains depends on their structure, composition, and depositional environment (Behrensmeyer et al. 2000; Gallagher 2014). A number of local environmental factors come into play, such as sedimentation rates and soil temperature, moisture, carbon, and nutrient content (Beck 1989; Berg and McClaugherty 2008; Hättenschwiler et al. 2005; Swift et al. 1979). Microbial and animal activity, freeze-thaw cycles, and geological processes can disturb the context of deposits and reduce the chances of preservation (Behrensmeyer et al. 2000; Birks 2007; Gallagher 2014; Pearsall 2000). Water-logged, acidic, arid, or frozen environments have greater potential for plant preservation.

It is important to consider which plants are over-, under-, or not represented in an archaeobotanical assemblage (Dieffenbacher-Krall 2007). Plant parts that are more robust, such as portions high in lignin, take longer to decompose than fragile portions, such as leaves (Beck 1989; Berg and McClaugherty 2008; Gallagher 2014). Some animals preferentially target certain plant species and others cannot withstand taphonomic processes (Dieffenbacher-Krall 2007; Gasser and Adams 1981). In most contexts, carbonization makes plant remains more resistant to

environmental damage and provides the best chance of preservation (Bryant 1989; Gallagher 2014; Märkle and Rosch 2008).

Other factors that influence macrobotanical assemblages are the sampling and recovery methods carried out by the archaeobotanist (Dincauze 2000; Keepax 1977). Carless processing in the lab can lead to contamination of samples with unrelated plant materials (Keepax 1977). The best way to identify and control for these problems is to have an archaeobotanist on site from the beginning of the project and to conduct analysis in conjunction with other archaeological data (Birks 2007; Dincauze 2000; Ford 1979; Lepofsky et al. 2001; Pearsall 2000). When assessing an archaeobotanical assemblage, it is necessary to evaluate the taphonomic context of the samples and consider the influence of non-cultural depositional processes (Dincauze 2000).

At the Upward Sun River site, carbonized remains have the greatest potential for preservation and I define uncarbonized botanical remains as recent contamination. Although the site contains evidence of habitation, it was likely occupied for a relatively brief period of time (Potter et al. 2014), resulting in fewer organic remains than that typically observed at long-term habitation sites. In addition, the massive loess deposits at the site and the lack of distinct inter-feature areas and structural boundaries made it difficult to delineate occupational surfaces in most circumstances. However, sediment samples were collected from inter-feature areas in addition to hearth features.

2.3.1 Macroremains in Hearth Feature Contexts

Carbonization offers the best chance of preservation for plant materials in a variety of environments, though it also biases archaeobotanical assemblages (Gallagher 2014). Carbonization occurs with the exposure of plant remains to low oxygen and temperatures between approximately 100 and 300˚C for short periods of time, which converts organic plant material to an inorganic carbon structure (Dincauze 2000; Gallagher 2014). Subsistence and food preparation practices determine which species are carbonized (Dieffenbacher-Krall 2007; Ford 1979; Hally 1981; Minnis 1981). For example, plant resources with parts that are not edible (such as nutshells and fruit pips) have a better chance of preservation because they are durable and are often disposed of near a fire. Resources such as grains, seeds, and nuts are dense but edible, meaning they have some chance of preservation if they are deposited by accident. Plant resources with soft tissue and high water content rarely preserve (Minnis 1981).

In interior Alaskan contexts, I argue that dense organic materials (such as hard seeds and woody portions of plants) are more likely to preserve and withstand carbonization than soft and fragile plant portions, such as leaves, buds, and soft seeds. Table 2.1 lists expectations for macroremain contributions of the plant taxa introduced in the seasonal model of plant resource exploitation in Chapter 4. Overall, tree and shrub taxa should dominate archaeobotanical assemblages produced in hearth feature contexts. Tree and shrub taxa have more hard parts that are high in lignin, which increases the chance of preservation and the likelihood of withstanding carbonization (Beck 1989; Berg and McClaugherty 2008; Gallagher 2014). Also, the ethnographic record mentions multiple uses for tree and shrub tax (such as for food, medicine, and functional purposes), they are present year-round, and they are purposefully introduced into hearth features as fuel (Kari 1985; Kuhnlein and Turner 1991). Charcoal analysis was outside the scope of this research, although further research on this topic could provide insight into the selection and use of certain taxa for fuel.

Table 2.1 Potential Macroremains of Plant Taxa. This table lists plant taxa, potential behavior associated with hearth feature use, and common macroremains that could enter into an archaeobotanical assemblage produced in these features.

Plant Type	Taxa	Associated Behavior or Use	Potential Macroremains
Woody Taxa	Alder, birch, spruce, balsam poplar, aspen, willow	Fuel, consumption, medicine, construction of tools and structures	Woody portions, buds and bud scales, needles
Berry and Fruit Bearing Taxa	Serviceberry, bearberry species, bunchberry, silverberry, crowberry, strawberry, juniper, bog cranberry, currant species, prickly rose, raspberry genus, soapberry, blueberry genus, high-bush cranberry	Immediate consumption, some cooking and preservation for storage	Berry and fruit seeds, woody portions from shrubby taxa
Leafy-Green Taxa	Wild chive, lady fern, fireweed, horsetail, Labrador Tea, cattail, Nootka lupine, roseroot, mountain sorrel, sour dock	Immediate consumption, some are cooked, preserved, or stored for future use	Typically no hard parts
Root and Tuber Taxa	Spiny wood fern, wild potato, mountain bistort, cinquefoil	Usually cooked or processed before consumption, some are stored	Roots and tubers

A hearth feature archaeobotanical assemblage could also contain berry and fruit bearing taxa, particularly if they are associated with heating and processing for storage. The ethnographic record notes the preservation of species such as low-bush and high-bush cranberry, blueberries, and bearberries in a heated fat mixture (Halpin 1987; Holloway and Alexander 1990; Jones 2010; Kari 1985). This is an example of a context in which plant remains could become incorporated into a hearth feature, carbonized, and preserved in the archaeological record. However, not all berries and seeds have equal chances of preservation. Dense seeds have a greater chance of preservation than those with soft tissue and high water content (Minnis 1981). Leafy-green taxa generally do not have hard parts that could withstand carbonization and leaves and soft parts decompose quickly (Gallagher 2014). Roots are generally processed and heated before consumption (Kari 1985; Kuhnlein and Turner 1991), which may increase the likelihood of deposition into the archaeobotanical record. However, the carbonized remains of roots and tubers may be indistinct and difficult to identify.

Chapter 3
Regional Background

The environment of interior Alaska is the product of complex relationships between global-scale climate forcing mechanisms, such as atmospheric and oceanic circulation patterns, and regional geology, geography, and ecology. This chapter describes the interaction between environment, human activity, and the archaeological record in interior Alaska. The first section details the modern environment of interior Alaska in relation to the preservation and recovery of archaeological remains. The second section discusses paleoenvironmental proxy records and outlines several periods of environmental and archaeological change that occurred during the Late Pleistocene and Holocene in interior Alaska. This information provides a contextual backdrop for model development in Chapter 4.

3.1 Modern Environment

The modern environment of interior Alaska influences site preservation and recovery potential. Associated difficulties include a highly seasonal environment that limits fieldwork to summer months, the presence of discontinuous permafrost throughout the interior, poor stratification, cryoturbation, acidic soils, and poor preservation of organic remains (Erlandson et al. 1991; Thorson 1990). These problems complicate most archaeological procedures, including radiocarbon dating, component delineation, and the development of cultural chronologies (Erlandson et al. 1991; Thorson 1990). The following subsections describe the geography, climate, ecology, and geology of interior Alaska to provide information related to the preservation and recovery of archaeological remains.

3.1.1 Geography

Three physiographic sections divide interior Alaska (Figure 3.1). The Yukon-Tanana Upland bounds the Tanana River Valley to the north, with ridges rising 150 to 500 m above the valley floor and a few lakes at lower elevations (Wahrhaftig 1965). The Tanana-Kuskokwim Lowland is a broad depression that was unglaciated during the Pleistocene, lying between the Yukon-Tanana Uplands and the Alaska Range (Wahrhaftig 1965). The Alaska Range bounds the region to the south, with peaks from 3,000 to 6,000 m above sea level (masl) and unglaciated foothills from 600 to 1,300 masl (Wahrhaftig 1965).

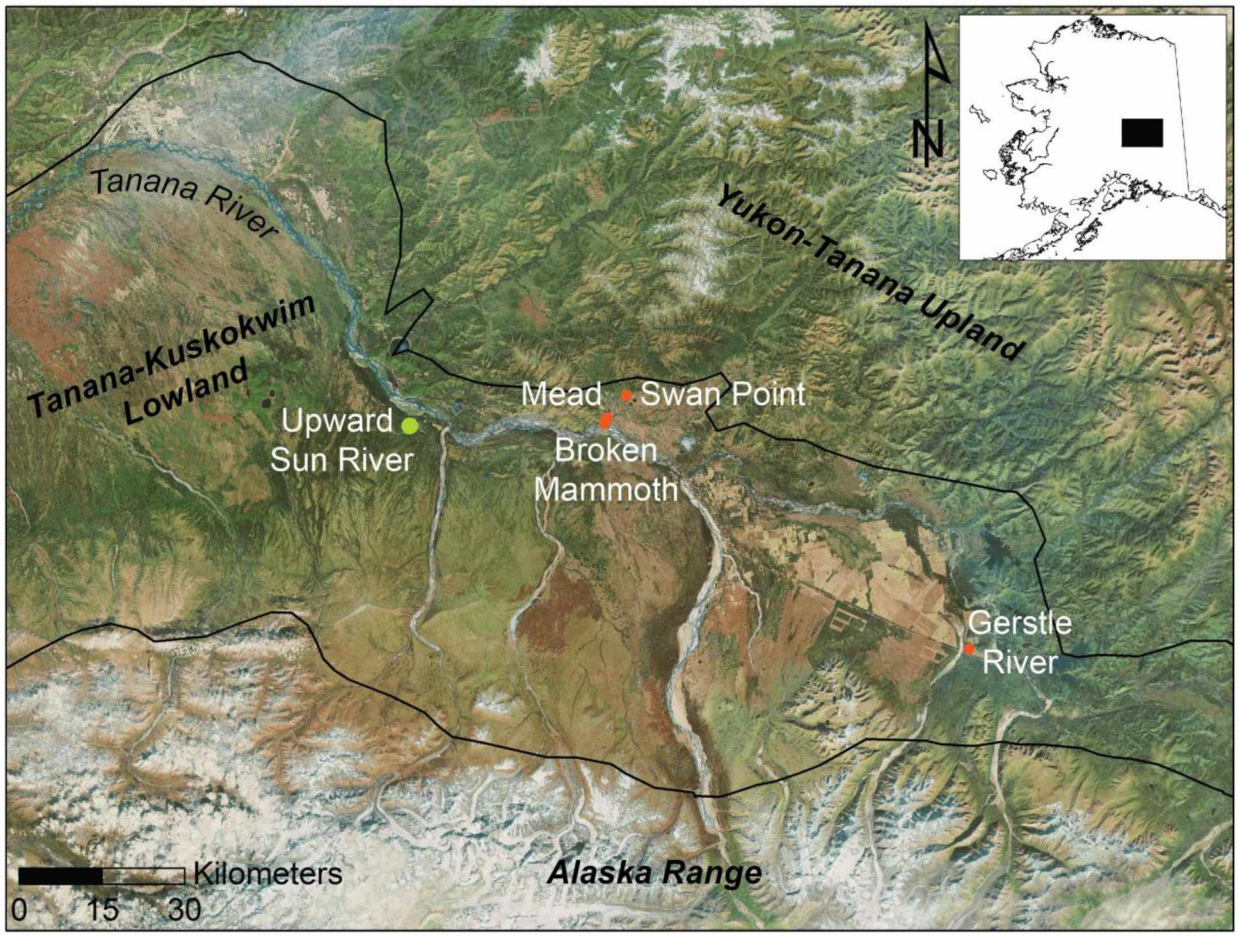

Figure 3.1 Physiographic Divisions. This map illustrates the physiographic divisions of interior Alaska and important archaeological sites discussed in this chapter (data layer GINA 2016).

The Tanana River flows approximately 700 km from its confluence at the Nabesna and Chisana Rivers northwest into the Yukon River, hugging the northern edge of the valley (Wahrhaftig 1965). Rapids occur near Tanacross and between the Goodpaster River and Fairbanks (Brooks et al. 1906). Silt-laden, glacially-fed tributaries join the Tanana River from the south and primarily clear-water tributaries join from the north (Brooks et al. 1906). Brooks et al. (1906) divide the river valley into three regions: the upper Tanana (the lowlands near the head of the river), the middle Tanana (the constricted region between the Tetlin and Delta Rivers), and the lower Tanana (the area extending west to the Tolovana River). Early ethnographers also used this division to describe native Athabascan populations residing in the river valley at the time of contact and some still use the classification today (Haynes and Simeone 2007; McKennan 1959).

3.1.2 Climate

The modern climate of interior Alaska is subarctic and continental, with extreme variation in seasonal temperature, precipitation, wind direction, and solar radiation that impacts plant and animal communities, which in turn affects human mobility and land use in the region (Shulski and Wendler 2007). The Brooks Range to the north and the Alaska Range to the south block coastal air masses and moisture from the Arctic and Pacific Oceans. Freeze-up typically occurs in late October or early November and break-up usually occurs in mid-May. Mean average temperature is below 0°C, with extreme summer highs of 37°C and winter lows of -60°C, resulting in discontinuous permafrost throughout the interior (Shulski and Wendler 2007). Annual precipitation is low, ranging from 25 to 50 cm. Most precipitation occurs as rain during the summer, while snowfall accumulates throughout the winter months. Hours of daylight range between four in January and up to twenty-two in April (Shulski and Wendler 2007).

3.1.3 Ecology

Factors such as relief, aspect, permafrost, moisture, fire regimes, and soil type influence the composition of vegetation communities (Gallant et al. 1995). The boreal forest of interior Alaska includes white and black spruce (*Picea glauca* and *P. mariana*, respectively), Alaska paper birch (*Betula neoalaskana*), aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*). Areas of higher elevation have tundra vegetation, with tree-line occurring at approximately 1000 m, though this varies depending on the local environment (Gallant et al. 1995). Lowlands contain swamps, bogs, and open and closed spruce forests, with larch (*Larix larcinia*) and black spruce (Gallant et al. 1995; Viereck and Little 2007). Alder (*Alnus* spp.), willow (*Salix* spp.), and balsam poplar form thickets and stands near rivers, lakes, and streams (Gallant et al. 1995; Viereck and Little 2007). Figure 3.2 illustrates the general land cover.

Animal taxa include black and grizzly bears (*Ursus americanus* and *U. arctos*, respectively), moose (*Alces alces*), caribou (*Rangifer tarandus*), Dall sheep (*Ovis dalli*), beaver (*Castor canadensis*), porcupine (*Erethizon epixanthum*), snowshoe hare (*Lepus americanus*), and other small mammals (Gallant et al. 1995). Fresh-water fish include whitefish (*Coregonus* spp.), pike (*Esox lucius*), lingcod (*Lota lota leptura*), and grayling (*Thymallus arcticus*). Most birds are migratory, including ducks and geese (*Anatidae* sp.), although ptarmigan (*Lagopus* sp.) and grouse (*Canachites* spp. and *Pedioecetes* spp.) are present year-round (Gallant et al. 1995).

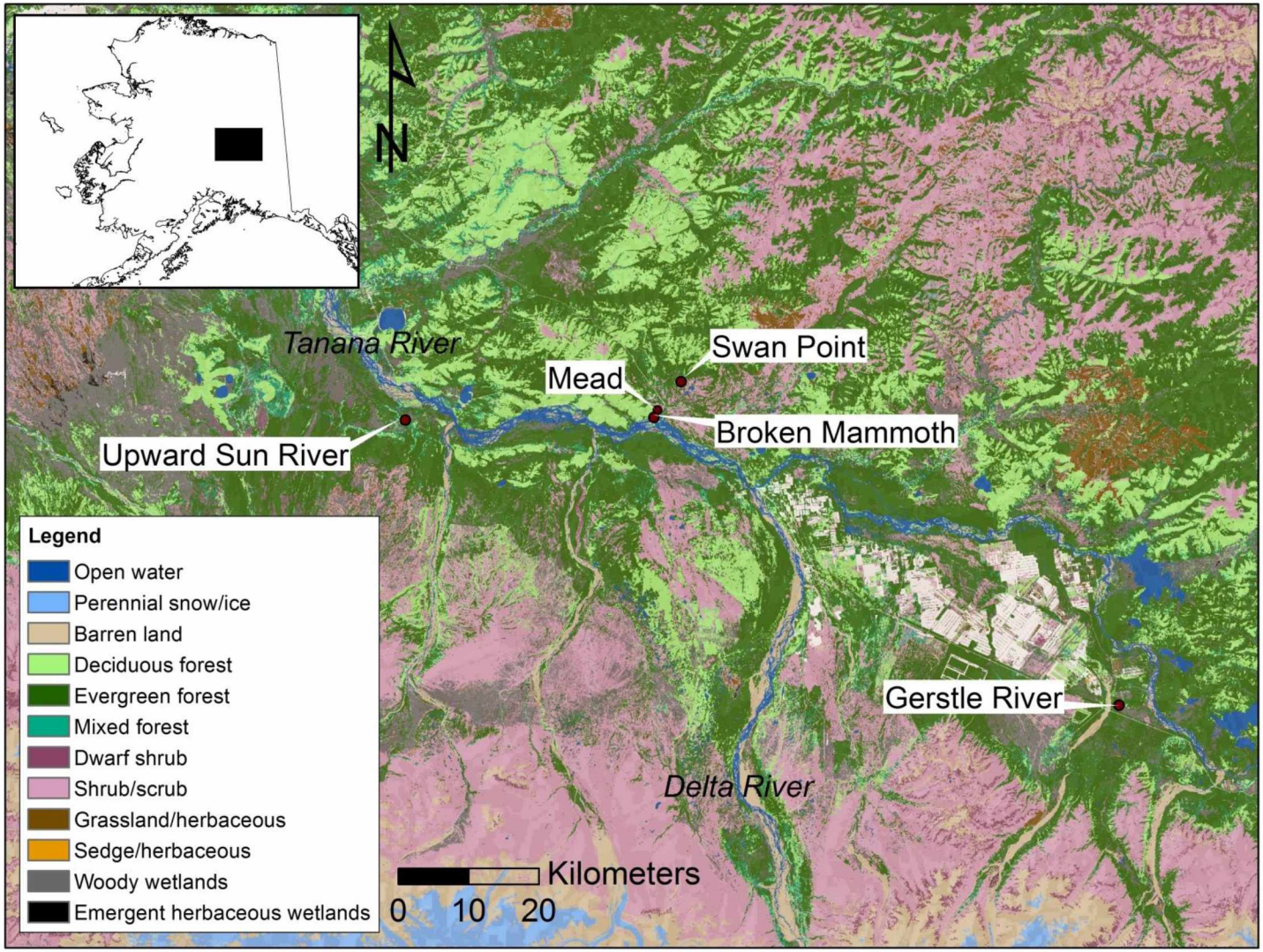

Figure 3.2 Middle Tanana Land Cover. This map illustrates the generalized land cover (data from USGS 2011) for the middle Tanana River basin and highlights some of the key archaeological sites discussed in the main text.

In the Tanana River basin, the Chena and Salcha Rivers have the largest chinook and chum salmon (*Oncorhynchus tshawytscha* and *O. keta*, respectively) runs in June and July, with an additional fall run of chum salmon from mid-July to early October (Savereide and Huang 2014; Spencer and Eiler 2007). In September, coho salmon (*Oncorhynchus kisutch*) run in the clear tributaries of the Delta and Nenana Rivers (Savereide and Huang 2014). Ethnohistoric records detail the differences in subsistence strategies for those that did not have access to salmon, such as the Upper Tanana Athabascans (McKennan 1959), and those that did, such as the Lower and Middle Tanana Athabascans (Andrews 1975). Salmon continue to influence the culture and subsistence practices of interior Alaskan communities (Savereide and Huang 2014; Spencer and Eiler 2007).

3.1.4 Geology

Geologic records of the most recent glacial period are important for considering impacts on human occupation in interior Alaska during the Late Pleistocene and Holocene. Widespread aggradation, terrace formation, and aeolian activity occurred during the Donnelly Glaciation (25,000-9500 yr BP), as well as dune formation adjacent to the Delta and Tanana Rivers (Reger et al. 2008; Reuther 2013). Environmental fluctuation impacted the Tanana River Valley during the last glacial period, though the region remained unglaciated. The furthest glacial advance into the interior left a terminal moraine approximately 25 km north of the Alaska Range (Péwé 1975). Along the northern boundary of the valley, aggradation of sand and gravel led to the damming of water and development of Harding, Birch, Quartz, and Healy Lakes (Péwé 1975).

In interior Alaska, surficial geology reflects periods of loess deposition, landscape stabilization, and soil development linked to glacial, aeolian, and fluvial processes. Loess is wind-transported sediment dominated by silt-sized particles (4 to 62 microns). Loess creates the most widespread surficial deposits in Alaska, capping pre-existing landforms and varying in thickness (Muhs et al. 2003). Most archaeological sites in interior Alaska are found as surficial artifact scatters (Bacon and Holmes 1980; Esdale et al. 2012; Potter et al. 2007a, 2007b). However, sites found in loess deposits overlying bluffs or terraces in the Tanana River basin are generally well-drained and accumulate soil carbonate that aids in the preservation of organic remains (Dilley 1998; Reuther 2013). Interior Alaskan loess originates in outwash fans on the Tanana, Nenana, and Yukon Rivers (Lagroix and Banerjee 2002; Muhs and Budahn 2006).

There are two models that consider the transportation and deposition of loess in interior Alaska. The first relates loess deposits to glacial periods, suggesting that loess is the product of glacial grinding of rocks, reworking in fluvial outwash, and transport and deposition through aeolian processes during snow free months (Begét 2001; Begét et al. 1990; Péwé 1975). Decreased vegetation cover and increased aridity and windiness during glacial periods could contribute to loess transportation (Begét 1996; Mahowald et al. 1999). This model relates interglacial periods with landscape stability and soil formation, reflected in the development of paleosols (Roberts et al. 2007). An alternative model emphasizes the role of loess production versus accumulation factors (Muhs et al. 2003). In this model, glacial periods encourage loess production, but not accumulation. Muhs et al. (2003) argue that sparse cover provided by herb-tundra vegetation of glacial periods does not serve as an affective loess trap, while greater vegetation cover during interglacial periods promoted sediment accumulation (Muhs et al. 2003).

3.2 Paleoenvironmental Controls and Proxy Records in Interior Alaska

Paleoenvironmental reconstruction is an inductive process that ultimately results in probabilistic statements about past environments based on proxy data (Caran 1998; Dincauze 1987). Proxies serve as representations of unobservable events or process. The uniformitarian concept that the present is the key to the past is central to paleoenvironmental reconstruction, suggesting that the processes that produce a proxy today also did so in the past (Caran 1998; Dincauze 1987). Archaeologists should place less confidence in a reconstruction as the level of extrapolation between the raw proxy data and conclusions grows (Caran 1998).

Equifinality complicates paleoenvironmental reconstructions, which refers to different processes producing the same result in a proxy record (Caran 1998; Dincauze 1987). For example, interior Alaskan palynological records show an increase in birch pollen around 14,000 cal yr BP, indicating a shift from herb-tundra to shrub-tundra due to increased summer temperatures, increased effective moisture, or both (Bigelow and Powers 2001). Bigelow and Powers (2001) suggest that shrub vegetation took advantage of warmer than modern summers and could tolerate the cooler than modern winters that resulted from changes in the earth's orbit at 14,000 cal yr BP. As illustrated with this example, addressing the problem of equifinality requires an understanding of a proxy's context and climate controls (Bartlein et al. 1991; Caran 1998; Dincauze 1987).

Problems with radiocarbon dating and the development of regional chronologies also complicate paleoenvironmental reconstructions. Bigelow and Powers (2001) outline some of the difficulties associated with comparing calibrated and uncalibrated chronologies, the presence of old carbon in lake deposits, and comparability of AMS and radiometric dates. In interior Alaska, old carbon can leach from peat deposits or erode from shorelines into lakes and become incorporated into lake sediments and aquatic organisms. This produces artificially old dates when bulk lake sediments are sampled (Abbott and Stafford 1996; Bigelow and Powers 2001). To avoid the problem of old carbon, researchers should focus on terrestrial remains for radiocarbon sampling (Bigelow and Edwards 2001; Bigelow and Powers 2001).

Directly dating paleoecological evidence from archaeological sites clarifies some of the problems associated with the chronology of proxy records. This research directly links regional paleoenvironmental proxy records with macrobotanical remains from the Upward Sun River site. Local-scale environmental change was likely the most visible to prehistoric foraging populations in interior Alaska in terms of impact on resource availability and change in surrounding habitats (Reuther 2013). Integrating these datasets allows for a better understanding of the relationship between local ecosystems and regional environmental change impacted by climate controls.

Late Quaternary climate controls include ice sheet size, variation in insolation, concentration of atmospheric carbon dioxide, sea level, sea surface temperature, sea ice, and snow cover (Bartlein et al. 1991). The presence of the Bering Land Bridge also impacted regional- and global-scale climate (Bigelow 2013). The connections between these controls influenced temperature, precipitation, and circulation patterns in the ocean and atmosphere (Bartlein et al. 1991). Local factors that affected paleoenvironment in interior Alaska include topography, aspect, vegetation, wind direction, moisture, and fire regimes (Lloyd et al. 2006).

Proxies for terrestrial paleoenvironment in Alaska include pollen, macrobotanical, sedimentological, paleontological, and glacial ice records. Many studies use these proxies to address question relating to the changing environments of the last glacial period and the transition to the Early Holocene, which is contemporaneous with the arrival and settlement of the first humans in the New World via the Bering Land Bridge (Goebel et al. 2008; Hoffecker and Elias 2007). This research considers many of these proxies when providing contextual paleoenvironmental information for model development.

Aeolian features, such as loess deposits, sand dunes, and sand sheets inform on environmental change in interior Alaska. Changes in vegetation, wind intensity, moisture, and atmospheric circulation influence periods of erosion, stability, and deposition in aeolian deposits (Reuther 2013; Wolfe and Nickling 1997). Geologists use optically-stimulated luminescence to directly date aeolian deposits to develop chronologies of environmental change (Lian 2007; Roberts et al. 2007). This thesis draws on sources such as Bigelow et al. (1990), Dilley (1998), and Reuther (2013) to understand the relationship between aeolian deposits and environmental change in interior Alaska. In addition, the following section incorporates site-specific evidence from Broken Mammoth, Swan Point, Mead, Upward Sun River, and Gerstle River into the discussion of aeolian deposition in interior Alaska (Gilbert 2011; Holmes 1996, 2001; Holmes et al. 1996; Potter 2005; Potter et al. 2011a, 2011b, 2014; Reuther 2013; Yesner et al. 1992).

Lacustrine records are another important source of information for past environmental change. Lake sediments reflect fluctuations in evaporation and precipitation rates that paleoecologists use to infer changes in temperature and effective moisture (Abbott et al. 2000). Factors such as windiness, air and soil temperature, vegetation, topography, aspect, and permafrost can influence lacustrine records, in addition to drainage basin characteristics (Barber and Finney 2000). This discussion of interior Alaskan paleoenvironment considers lake level reconstructions from Birch, Harding, Jan and Quartz Lakes (Abbott et al. 2000; Bigelow 1997; Carlson and Finney 2004; Finkenbinder et al. 2014; Nakao et al. 1981; Wooller et al. 2012).

Paleoecologists also sample lake cores for pollen and plant macroremains (Bigelow 2013; Birks 2007). General reconstructions of vegetation history in interior Alaska are helpful for summarizing overall change in environment (Ager 1983; Ager and Brubaker 1985; Anderson and Brubaker 1993; Anderson et al. 2004; Bigelow 2013). Interior Alaskan palynological evidence includes records from Birch, Harding, Jan, Lost, and Windmill Lakes (Bigelow 1997; Bigelow and Edwards 2001; Carlson and Finney 2004; Finkenbinder et al. 2014; Tinner et al. 2006). Tinner et al. (2006) and Zazula et al. (2006a, 2006b) also consider macrobotanical evidence for paleoenvironmental reconstruction in Alaska and surrounding regions.

There are several benefits to supplementing pollen-based vegetation reconstructions with macrobotanical evidence (Birks 2007). Macrobotanical remains are often identifiable to a higher taxonomic resolution than pollen. For example, tree and shrub birch (*Betula neoalaskana* and *B. glandulosa*, respectively) are difficult to distinguish in the pollen record, but they can be easier to

identify as macroremains (Birks and Birks 2000). Plant macroremains can also represent taxa that do not produce pollen and can overcome problems with over-representation of taxa that produce more pollen than other species, such as birch (Bigelow and Powers 2001; Birks 2007). However, pollen is generally identifiable to the genus level and it can record changes in plant productivity, with low pollen abundance reflecting relatively sparse vegetation cover (Bigelow 2013). Pollen reflects regional vegetation because it is transported over greater distances when compared to macroremains, particularly for taxa such as *Artemesia* and birch. Macrobotanical remains reflect the local vegetation because they generally undergo deposition in their immediate environment (Birks 2007; Birks and Birks 2000).

Faunal remains from paleontological and archaeological contexts are important for paleoecological reconstruction (Guthrie 1982, 2001, 2006). Paleoecologists use modern species as an analog for prehistoric species. If a species from a zooarchaeological or paleontological assemblage favors a specific habitat, then paleoecologists assume that the ecosystem existed in the past. As environmental conditions change, the presence and distribution of species also fluctuates with the reduction or expansion of associated habitats. Guthrie (1968, 1982, 1984, 1990, 2001, 2003, 2006) provides an overview of zooarchaeological and paleontological evidence present in Alaska, as do Eger et al. (2009), Loehr et al. (2006), MacPhee and Greenwood (2007), and Stephenson et al. (2001).

3.3 Paleoenvironment and Archaeology in Interior Alaska

In this section, I define six periods of environmental and archaeological change in interior Alaska: the Last Glacial Maximum (~25,000 to 14,000 cal yr BP), the Late Glacial (~14,000 to 13,000 cal yr BP), the Late Pleistocene to Early Holocene transition (~13,000-11,500 cal yr BP), the Early Holocene (~11,500-6000 cal yr BP), the Middle Holocene (~6000 to 1000 cal yr BP), and the Late Holocene (~1000 cal yr BP to present). These periods are useful for considering the relationship between environmental change and human behavior (Anderson and Brubaker 1993; Anderson et al. 2004; Bigelow 2013; Holmes 2001; Potter 2008a, 2008b, 2011; Yesner 2001, 2007). For this discussion, I incorporate archaeological evidence from five well-stratified, multi-component sites from the Tanana River Valley: Upward Sun River (XBD-298), Mead (XBD-071), Swan Point (XBD-156), Broken Mammoth (XBD-131), and Gerstle River (XMH-246). When a broader context is needed, I include evidence from other interior Alaskan sites.

3.3.1 The Last Glacial Maximum (~25,000 to 14,000 cal yr BP)

Although many archaeologists suggest that humans did not arrive in the New World until approximately 14,000 cal yr BP (Goebel et al. 2008), it is important to consider the conditions of the Last Glacial Maximum that shaped the landscape they came into contact with. The Last Glacial Maximum was a period of cooler than modern temperatures and glacial advance. Lower global sea levels (approximately 120 m below modern) left the Bering Land Bridge exposed, allowing for passage of animal and vegetation communities between the two continents (Hoffecker and Elias 2007). The exposure of this land-mass decreased maritime effects on climate and increased the continentality of interior Alaska (Bigelow 2013). The presence of the Laurentide Ice Sheet affected temperatures and aridity, though the Tanana River basin remained unglaciated. Regions nearer to the ice sheet were cooler and more arid than elsewhere (Bartlein et al. 1991; Braconnot et al. 2007).

The oldest lacustrine records in interior Alaska date to before the Last Glacial Maximum at Harding Lake, though it was likely desiccated throughout most of this period because of arid conditions (Ager 1983; Finkenbinder et al. 2014; Nakao et al. 1981). However, increased precipitation and moisture availability by 16,000 cal yr BP resulted in a rise in water levels at Harding Lake and the development of Birch, Jan, Lost, and Windmill Lakes (Abbot et al. 2000; Ager 1983; Ager and Brubaker 1985; Barber and Finney 2000; Bigelow 1997; Bigelow et al. 2003; Bigelow and Edwards 2001; Nakao et al. 1981; Tinner et al. 2006).

Before 14,000 cal yr BP, interior Alaskan vegetation was a mosaic of graminoid- and herbaceous-tundra, with a minor shrub-tundra component in moister areas (Anderson et al. 2004; Bigelow et al. 2003). Pollen records at Birch, Harding, Lost, and Windmill Lakes contain evidence of a combination of grasses (Poaceae), sedges (Cyperaceae), and *Artemesia* (Ager 1983; Ager and Brubaker 1985; Bigelow et al. 2003; Bigelow and Edwards 2001; Tinner et al. 2006). Evidence suggests the mesic-adapted shrub-tundra vegetation present in the lowest elevations in central Beringia served as a barrier to flora and fauna on either side of the land bridge that were adapted to drier conditions (Elias and Crocker 2008; Guthrie 2001; Yurtsev 2001). The pollen records of Alaska contain small percentages of spruce dating to this period (Brubaker et al. 2005). This suggests that the taxon likely survived in refugia throughout the Last Glacial Maximum, which allowed it to quickly expand during the Holocene (Anderson et al. 2010; Bigelow 2013; Brubaker et al. 2005; Zazula et al. 2006b).

In interior Alaska, faunal records dating to the Last Glacial Maximum suggest a variety of mammals were present on the landscape. Mammoth (*Mammothus* sp.), bison (*Bison priscus*), wapiti (*Cervus elaphus*), muskox (*Ovibos moschatus*), and horse (*Equus* sp.) were present, with fluctuations in abundance and distribution likely impacted by changes in the environment (Guthrie 2006; MacPhee and Greenwood 2007; Matheus et al. 2003). Caribou and Dall sheep were present in Beringian refugia throughout the Last Glacial Maximum (Eger et al. 2009; Loehr et al. 2006). Small mammal remains included voles (*Microtus* spp.), hares (*Lepus* spp.), lemmings (*Lemmus* spp. and *Dicrostonyx* spp.), and ground squirrels (*Spermophilus* spp.; Guthrie 1968; Zazula et al. 2007).

3.3.2 The Late Glacial Period (~14,000 to 13,000 cal yr BP)

Several changes occurred in the environment of Beringia during the Late Glacial period. After 14,000 cal yr BP, pollen records show a rise in birch pollen, likely the shrub variety (*Betula glandulosa*), and willow pollen (Bigelow and Powers 2001). Shrub-tundra vegetation communities became dominant over herbaceous-tundra vegetation communities at this time (Bigelow and Powers 2001). This corresponds to the Bølling-Allerød interstadial, a global climate period identified in Greenlandic ice cores that was characterized by warmer or wetter conditions (Bigelow and Edwards 2001; Björck 2007; Viau et al. 2008). The gradual inundation of the Bering Land Bridge also affected the climate of interior Alaska, resulting in decreased continentality and increased precipitation and moisture availability (Bigelow 2013).

The relationship between paleoecology and faunal communities in Beringia during the Late Pleistocene is a popular topic of research (Guthrie 2006). Vertebrate paleontologists such as Guthrie (1982, 2001) argue that only a highly productive, grass-dominated steppe-tundra could support Late Pleistocene megafauna. However, Anderson and Brubaker (1993) and Ritchie and Cwynar (1982) suggest a low productivity, herb-dominated tundra based on pollen records. Further research incorporated into this debate suggests that vegetation during the last glacial period was likely a mosaic of different communities, some of which could support large mammal grazers (Elias et al. 1997; Goetcheus and Birks 2001; Guthrie 2001; Hoffecker and Elias 2007). Zazula et al. (2006a) argue that available moisture, drainage, aspect, and elevation determined local vegetation communities. They propose a mosaic of xeric-steppe, fens, mesic graminoid meadows, steppe-tundra, and herb-tundra (Zazula et al. 2006a).

A related topic of research is the relationship between notable large mammal extinctions (such as mammoth and horse) and the arrival of humans into the New World. Specific extinction hypotheses include over-hunting by humans or habitat reduction due to climate change (Guthrie 1982, 1984, 1990, 2001). Interior Alaskan faunal records suggest the continued presence of Last Glacial Maximum taxa such as bison, wapiti, and a variety of small mammals during the Late Glacial period in interior Alaska (Guthrie 1968, 2006; MacPhee and Greenwood 2007; Matheus et al. 2003; Zazula et al. 2007).

Tanana River Valley archaeological sites reflect the environmental conditions of the Late Glacial period. Before occupation at Mead, Broken Mammoth, and Swan Point, the Late Glacial was a period of intense weathering and frost shattering of underlying bedrock, resulting in the production of quartz ventifacts and bedrock rubble (Dilley 1998). A decrease in wind intensity or increased vegetation cover led to the deposition and accumulation of gray aeolian sands atop the pre-existing landforms at the Mead and Broken Mammoth sites by around 14,000 cal yr BP, with sediment likely sourced from the Tanana River and surrounding dune areas (Dilley 1998; Gilbert 2011; Reuther 2013). Aeolian sands at Gerstle River also date to this time (Potter 2005).

The earliest evidence for human activity in interior Alaska dates to the Late Glacial period (~14,000 cal yr BP), found at Swan Point Cultural Zone (CZ) 4 (Holmes 2001). This early archaeological evidence has important implications regarding the peopling of the New World, with similarities in the technological and faunal evidence present at Siberian Diuktai sites (Holmes 2008). The Diuktai Complex includes willow-leaf bifaces, microblades, wedge-shaped microblade cores, and evidence of osseous technology, often found in association with mammoth, horse, and bison (Mochanov and Fedoseeva 1996; Potter et al. 2013). At Swan Point, zooarchaeological evidence includes mammoth and horse remains that directly date to the time of cultural occupation, which are not found elsewhere in eastern Beringia. The lithic and faunal assemblages from Swan Point CZ 4 could reflect a transitional period from the large mammal emphasis of Diuktai economies to later eastern Beringian subsistence practices, which broaden to include small game, birds, and fish to supplement bison and wapiti (Potter et al. 2013).

Before the establishment of Swan Point CZ 4 as the oldest occupation in central Alaska, West (1967) made connections between the technology of eastern and western Beringia. The Diuktai culture of western Beringia was thought to be antecedent to the eastern Beringian Denali Complex, which consists of wedge-shaped microblade cores, Donnelly burins, bifacial knives,

endscrapers, and lanceolate projectile points. Archaeologists questioned this connection when they determined that dates for many of the sites used to define the complex were inaccurate, with the Campus site falling in the Middle Holocene (Mobley 1996) and Teklanika West site dating to approximately 7,000 BP (see Coffman and Potter 2011; Goebel and Bigelow 1992, 1996).

In addition to technological and subsistence connections between Siberia and Alaska, linguistic and genetic evidence supports the hypothesis for the peopling of the New World by way of the Bering Land Bridge. Recent work establishes a connection between the North American Na-Dene and Siberian Yeneseian language families (Kari and Potter 2010). A variety of genetic evidence also indicates relationships between Native American and Asian populations (Mulligan et al. 2008; Raghavan et al. 2014a, 2014b; Reich et al. 2012). Human remains with preserved ancient DNA are rare and only seven New World sites with human remains older than 8,000 years have undergone DNA analysis (Chatters et al. 2014; Raff et al. 2011; Rasmussen et al. 2014, 2015). Recent analysis of a double infant burial (around 11,500 cal yr BP) at Upward Sun River informs on the genetic diversity in Late Pleistocene and Early Holocene Beringia and the connections between Asia and the Americas (Potter et al. 2014; Tackney et al. 2015).

Climatic amelioration at the end of the Late Glacial period likely led to the loess deposition visible in the stratigraphy of interior Alaskan archaeological sites, burying underlying gray sand and bedrock layers (Dilley 1998; Reuther 2013). Subsequent stabilization led to soil and paleosol development, which often correlates with the first cultural occupations. Evidence for early occupation at Tanana River Valley sites includes Mead CZ 5 and 4 (approximately 13,300 and 13,000 cal yr BP, respectively; Potter et al. 2011b), Broken Mammoth CZ 4 (around 13,300 cal yr BP; Holmes 1996), and Upward Sun River Component 1 (around 13,200 cal yr BP; Potter et al. 2011a).

Overall, the archaeological evidence recovered from early occupations in interior Alaska varies between sites. Lithic and faunal evidence suggests a relatively broad diet breadth in which small mammals and waterfowl supplemented a diet primarily focused on bison and wapiti (Potter 2011; Potter et al. 2013; Yesner 2001). The incorporation of small mammals and waterfowl into the diet possibly influenced subsistence and land use practices for Late Glacial period foragers. Logistically mobile task groups likely pursued large game, while those remaining at central base camps could opportunistically forage for some small game and birds (Potter et al. 2013).

3.3.3 The Late Pleistocene to Early Holocene Transition (~13,000-11,500 cal yr BP)

The transition from the Late Pleistocene to the Early Holocene coincides with the Younger Dryas climatic event, approximately 12,900 to 11,700 cal yr BP (Björck 2007; Kokorowski et al. 2008). On a global-scale, this was a period of cooling and aridity, although paleoenvironmental records identify regional variation in responses to this event (Björck 2007; Viau et al. 2008). A rise in global sea level led to the inundation of the Bering Land Bridge, though lower than modern sea levels left some areas of Beringia that are now flooded exposed (Bartlein et al. 2015). The diminished Laurentide Ice Sheet remained in eastern Canada, but it did not influence atmospheric circulation to the same degree as it had previously (Bartlein et al. 1991). By 13,000 cal yr BP, the Ice Free Corridor between the Cordilleran and Laurentide Ice Sheets opened. This allowed for movement between Beringia and central North America, though fluctuation in vegetation communities and environmental conditions likely determined the ease of access through the corridor (MacDonald and McLeod 1996).

Shrub-tundra taxa, such as dwarf birch, still dominated vegetation communities in interior Alaska (Ager 1983; Bigelow and Edwards 2001). In ecologically sensitive areas, such as ecotones and higher elevations, herb and grass vegetation communities reemerged after their decline at the end of the last glacial period due to the slight increase in aridity or cooling (Bigelow and Edwards 2001). Palynological records from Birch and Lost Lakes reflect these trends, but not Harding or Jan Lakes (Ager and Brubaker 1985; Bigelow 1997; Carlson and Finney 2004; Tinner et al. 2006). Lake levels fluctuated slightly in response to more arid conditions, though in general they continued to rise to their modern depths. Birch Lake records indicate a decrease in water level around 13,000 cal yr BP. Less fluctuation occurred at Jan Lake (Abbott et al. 2000). Quartz Lake developed at approximately 11,200 cal yr BP, shortly after the Younger Dryas (Wooller et al. 2012). The discrepancies in palynological and lake level records support the hypothesis for variability in local responses to the Younger Dryas.

When applied throughout this thesis, the term ecotone refers to transitional zones between relatively homogeneous vegetation communities, which can exhibit characteristics of adjacent habitants and distinctive microhabitats (Clary and Medin 1999; Risser 1995). Ecotone transitions generally result from physical changes in the environment, which impact ecosystems and the distribution of organisms, and exist at local- and regional-scales (Gosz and Sharpe 1989). The species that occur in ecotones are often at the margin of their environmental distribution,

which suggests that they may be sensitive to slight changes in the ecosystem (Gosz and Sharpe 1989). The transition between riverine or lacustrine aquatic ecosystems and terrestrial ecosystems is an example of a local ecotone, on the scale of kilometers. A regional example of an ecotone, on the scale of hundreds of kilometers, is arctic tree-line, referring to the northern most extension of trees at the transition from the Subarctic to the Arctic. Alpine tree-line is also an example of an ecotone.

The transition from the Late Pleistocene to the Early Holocene was a period of important ecological change. The fluctuation in vegetation communities due to climate change resulted in shifts in habitat size and distribution for animals. For some species, these changes were beneficial and allowed for population expansion. The substantial change in environment and possible over-predation by humans led to the extinction of some large grazers in interior Alaska (Potter et al. 2013). Mammoths were extinct in the region by approximately 12,000 cal yr BP, around which time horse remains decline in the record (Grayson 2007; Guthrie 2003). Moose (*Alces alces*) appear in the Alaskan zooarchaeological record around 13,000 cal yr BP, while bison and wapiti abundance increases (Guthrie 2006). The fluctuation in floral and faunal communities throughout the Younger Dryas may have led to a time of resource stress that influenced resource procurement strategies for interior Alaskan foragers. Although Late Glacial zooarchaeological remains suggest a relatively broad diet, diet breadth expanded further during the transition from the Late Pleistocene to the Early Holocene to include a greater proportion of small game, fish, and birds in addition to large mammals (Potter et al. 2013).

Aeolian deposits found in interior Alaska also record environmental changes. For example, Bigelow et al. (1990) link the Younger Dryas to an increase in sediment grain size that suggests a period of high wind intensity. Reuther (2013) notes a reactivation of the Rosa Keystone Dune Field in interior Alaska around 12,900 to 12,640 cal yr BP at the beginning of the Younger Dryas. Between 12,640 and 9,000 cal yr BP, a series of weak soils associated with natural forest fires developed (Reuther 2013). The development of these soils is contemporaneous with an increase in charcoal at Lost Lake (Reuther 2013; Tinner et al. 2006).

At Mead and Broken Mammoth, a brief period of loess deposition around 12,800 cal yr BP buried the lower paleosols, followed by re-stabilization of the landforms around 12,600 cal yr BP (Dilley 1998; Gilbert 2011). Following re-stabilization during the middle Younger Dryas, humans reoccupied Mead and Broken Mammoth during CZ 3 (both approximately 12,000 cal yr

BP; Holmes 1996; Potter et al. 2011b). Terminal Younger Dryas cultural occupations include Component 2 at Upward Sun River, which is associated with a series of buried soils in the upper loess deposit, and CZ 3 at Swan Point, which occurs after an approximately 1,000-year hiatus in occupation (both occupations date to around 11,700 cal yr BP; Holmes 1996; Potter et al. 2011a).

Cultural historical explanations originally dominated archaeological reasoning in interior Alaska. This approach described archaeological complexes as the result of separate cultures and populations using the same region at different times. The Nenana Complex was defined not long after the Denali Complex and was based on the assemblage from Component 1 (around 13,000 cal yr BP) at the Dry Creek Site (Powers and Hoffecker 1989). This complex includes core and blade technology, bifaces, endscrapers, and planar scrapers, as well as the triangle and tear-drop shaped Chindadn points, which Cook (1969) originally defined from materials at the Healy Lake Village site. Evidence of Denali overlying Nenana Complex components in the Nenana River Valley and pre-Younger Dryas radiocarbon ages for the Nenana Complex suggested that it was older than the Denali Complex (Goebel and Bigelow 1992; Powers and Hoffecker 1989). However, the presence of microblades at the earliest component in interior Alaska, Swan Point CZ 4 (Holmes 2001), complicates the premise that the Nenana Complex lacks microblades.

Some researchers suggest functional or seasonal explanations for the variability exhibited in Late Pleistocene and Early Holocene lithic technologies. These archaeologists argue that the differences exhibited between sites and components reflect different site occupants, function, or seasonality (Holmes 2001; Potter et al. 2013; West 1996). For example, upland sites often contain bifaces and associated Dall sheep and caribou remains, while lowland sites frequently contain microblades and related bison and wapiti remains (Potter 2008a, 2011). Potter (2008a) defines lowland and upland settings and places the distinction at approximately 500 masl. Upland locations include the foothills of the Alaska Range and the Yukon-Tanana Upland and lowland settings include low-elevation portions of the Tanana River basin (Potter 2008a). Higher elevations contain open mixed forests and tundra. Hill slopes at lower elevations contain closed forests. The lowest elevations contain muskeg and black spruce forests (Viereck and Little 2007). The differential distribution of technologies in upland and lowland settings and overlap in time suggests functional or seasonal assemblage differences (Potter 2008a).

Despite the difficulties associated with interior Alaskan cultural chronologies, increased evidence of residential sites broadens our understanding of human activity in the region during

the Late Pleistocene and Early Holocene. The abundance of short-term hunting camps in the archaeological record biases the picture of human activity in favor of hunting and male-dominated subsistence practices. Component 3 at the Upward Sun River site contains the oldest evidence for a habitation site and mortuary behavior (around 11,500 cal yr BP) in northern North America (Potter et al. 2011a, 2014). In addition, the earliest evidence for human exploitation of chum salmon dates to this cultural occupation (Halffman et al. 2015). These data shed light on aspects of human activity that were previously unknown and helps link prehistoric and recent lifeways in interior Alaska.

3.3.4 The Early Holocene (~11,500-6000 cal yr BP)

Climatic conditions shifted to warmer temperatures, but remained relatively dry, during the Holocene Thermal Maximum (11,500 to 9100 cal yr BP) due to changes in Milankovitch cycles (Abbott et al. 2000; Barber and Finney 2000; Edwards et al. 2005). The shift in Earth's orbit increased summer insolation and decreased winter insolation for the northern hemisphere (Kaufman et al. 2004). Increased summer temperatures encouraged the spread of tree taxa, such as *Populus* (aspen or balsam poplar), and the development of open forests in interior Alaska, as noted in pollen records at Birch, Harding, Jan, Lost, and Windmill Lakes (Ager 1983; Anderson et al. 2004; Bigelow 1997; Bigelow and Edwards 2001; Carlson and Finney 2004; Edwards et al. 2005; Lloyd et al. 2006; Tinner et al. 2006). Shrub-birch and willow continued to serve as a major component of vegetation communities (Anderson et al. 2004; Bigelow 2013).

After approximately 10,000 cal yr BP, spruce became more abundant on the landscape as moisture levels increased, which is evident in pollen records at Birch, Harding Jane, and Lost Lakes (Ager 1983; Ager and Brubaker 1985; Bigelow 1997; Bigelow and Powers 2001; Carlson and Finney 2004; Lloyd et al. 2006; Tinner et al. 2006). Palynologists have established that white spruce expanded first, but remained in warm regions such as valley bottoms and well-drained slopes (Anderson et al. 2004). Spruce presence declined between 9000 and 7000 cal yr BP, but later increased with the expansion of both white and black spruce (Anderson et al. 2004; Mason and Bigelow 2008). Alder abundance increased by around 8000 cal yr BP at Birch, Harding, Jan, and Lost Lakes (Ager 1983; Bigelow 1997; Carlson and Finney 2004; Tinner et al. 2006).

Low-intensity fires and aridity occurred between 10,000 and 6000 cal yr BP (Lloyd et al. 2006). Charcoal from lacustrine records serves as evidence for natural fires at sites such as Birch,

Dune, Farewell, and Jan Lakes (Franklin-Smith et al. 2004; Hu et al. 2006; Lloyd et al. 2006; Lynch et al. 2002). The presence of sphagnum moss (*Sphagnum*) increased around 7200 years ago, interpreted as paludification of the landscape and development of muskegs and bogs (Mason and Bigelow 2008). By 6800 cal yr BP, the boreal forest developed in central Alaska (Anderson et al. 2004; Bartlein et al. 1991). Black spruce became central to vegetation communities at Birch, Jan, and Lost Lakes (Bigelow 1997; Carlson and Finney 2004; Tinner et al. 2006). Changes in fire regimes likely influenced the transition from white to black spruce dominance in interior Alaska. Despite a more mesic landscape, fire frequency increased after 6000 cal yr BP (Hu et al. 2006; Lloyd et al. 2006). In general, white spruce is less fire-tolerant than black spruce and the success of the latter species is associated with an increase in fire frequency in interior Alaska throughout the Holocene (Hu et al. 2006).

Lake levels in the Tanana River Valley approached their modern depths during the Holocene, with some fluctuation. Levels at Jan Lake continued to rise toward modern during the Holocene (Barber and Finney 2000; Carlson and Finney 2004). By 8000 cal yr BP, modern lake levels were established and Birch and Harding Lakes (Abbott et al. 2000; Nakao et al. 1981). The dominance of black spruce over white spruce indicates the increase in moisture in interior Alaska throughout the Holocene (Hu et al. 2006).

Ecosystem change and habitat reduction for grazing species continued to influence animal populations in interior Alaska, which in turn impacted resource availability and subsistence practices for human occupants in the region (Guthrie 1990). Some evidence suggests that wapiti went locally extinct between 9000 to 8000 cal yr BP (Guthrie 2006), though later specimens have been found (Potter 2005). Bison abundance continued to decline, though they were still present until the Late Holocene (Stephenson et al. 2001). While one study based on aDNA recovered from frozen soils in interior Alaska claims that mammoth and horse survived until approximately 10,500 to 7500 cal yr BP (Haile et al. 2009), confirmation requires more research to address the reliability of animal aDNA studies from soils. Muskox, caribou, and Dall sheep were present in the interior throughout the early and Middle Holocene (Eger et al. 2009; Loehr et al. 2006; MacPhee and Greenwood 2007).

Interior Alaskan archaeological sites reflect the changes in environmental conditions that occurred in the Early Holocene. The newly developed open hardwood forests associated with warm and well-drained soils encouraged the development of paleosols around 11,500 cal yr BP

(Dilley 1998; Reuther 2013). Components 3 and 4 at the Upward Sun River site correspond with periods of landscape stability and forest soil development, dating to approximately 11,500 and 10,000 cal yr BP, respectively (Reuther 2013). Initial occupation at the Gerstle River site occurred at approximately 11,200 cal yr BP during Component 1 (Potter 2005).

A period of increased aeolian activity occurred in interior Alaska between 11,500 and 8000 cal yr BP, burying soils shortly after they developed (Dilley 1998). During this time, humans abandoned Mead, Broken Mammoth, and Swan Point. All three sites exhibit a coarsening of sediment deposited during this time due to local variability in precipitation, vegetation cover, and aeolian activity (Dilley 1998). Soon after, human occupants returned to Broken Mammoth and Swan Point (CZ 2) and the landforms stabilized enough for the development of weak upper paleosols (Dilley 1998).

The trends in occupation visible at Gerstle River are opposite of those seen at other interior Alaskan sites, perhaps due to differences in site function (Potter 2005). Gerstle River Components 2, 3, and 4 (approximately 10,800, 10,100, and 9700 cal yr BP, respectively) correspond to active periods of loess deposition with no soil development and likely limited vegetation cover (Potter 2005). Buried soils intersperse periods of occupation and potentially reflect the establishment of open hardwood forests in the region (Potter 2005). Component 5 at Gerstle River (approximately 8800 cal yr BP) corresponds to a period of weak soil development (Potter 2005). The Gerstle River (Potter 2005), Delta River Overlook (Bacon and Holmes 1980), and Hurricane Bluff (Potter et al. 2007b) sites contain a complex record of forest soil development between approximately 9000 and 4000 cal yr BP.

Major changes in subsistence and settlement practices occurred during the Holocene in interior Alaska. Early Holocene zooarchaeological evidence suggests a transition from a broad diet breadth that included low-return, predictable resources to a specialized diet emphasizing high-return large mammals (Potter et al. 2013). Bison and wapiti procurement occurred in lowland settings, while small mammals and birds decline in the record and fish are absent (Potter et al. 2013). These trends are visible in the faunal record from occupations such as Component 3 at Gerstle River, which Potter (2005) defines as a logistically organized hunting camp. Low-yield elements dominate the assemblage, while high-yield elements are missing, suggesting that foragers processed useful portions of bison and wapiti at the hunting camp then transported them back to a base camp (Potter et al. 2013). Mead CZ 4 records the opposite pattern (Potter et al.

2013). From an optimal foraging perspective, specialization on high-return large mammals and emphasis on only high-yield elements suggests a period of resource abundance.

A related change was the gradual shift from residential to logistical mobility throughout the Holocene, though this likely occurred on a spectrum and both strategies were used (Potter 2008b). The faunal assemblage from logistically organized hunting camps, such as Gerstle River Component 3, can serve as point of comparison to earlier residential components, such as Upward Sun River Component 3 and Mead CZ 4. The variation in assemblages reflects the importance of both central based foraging for locally available small game, birds and fish in Younger Dryas aged components, as well as the increased importance of logistically organized hunting for bison and wapiti during the Early Holocene (Potter et al. 2013).

Yesner (2001) notes the importance of climatic amelioration during the Early Holocene for the establishment of waterfowl habitats in interior Alaska. The North Pacific flyway waterfowl migration route was established following the dissolution of the Bering Land Bridge. Although foraging strategies primarily revolved around bison and wapiti procurement during this period, waterfowl may have become increasingly important as a seasonally predictable resource due to the decreased presence of large mammals such as bison and wapiti during the Holocene (Yesner 2001). Similarly, Fiedel (2007) suggests that glacial meltwater lakes may have provided habitats for waterfowl in the Ice Free Corridor. Foraging populations may have followed waterfowl as a subsistence resource, which could have encouraged human movement between Alaska and central North America (Fiedel 2007).

In terms of technology, Denali Complex assemblages appear in variable forms throughout this period (Dixon 1985; Hamilton and Goebel 1999). Ice-patch archaeological data from Alaska and surrounding regions suggests the prevalence of atl'atl and dart technology (Hare et al. 2004). An ice-patch in the Yukon contained the oldest dated dart shaft fragment, at approximately 9300 cal yr BP (Hare et al. 2004). These records suggest mixed use of birch, spruce, and willow species for the construction of implements and structures. The availability of these resources likely fluctuated with environmental conditions.

3.3.5 The Middle Holocene (~6000 to 1000 cal yr BP)

By approximately 6000 cal yr BP, the rate of sedimentation in interior Alaska slowed, though finer-grained loess deposition began around this time and still occurs today (Dilley 1998).

As sedimentation rates decreased during the Middle Holocene, modern boreal forest vegetation communities and associated soils developed between 5000 and 2000 cal yr BP (Bigelow 1997; Dilley 1998). Increasing moisture, paludification of the landscape, changing disturbance and fire regimes, or decreasing summer temperatures allowed for the dominance of black spruce in interior Alaska (Hu et al. 2006; Lloyd et al. 2006). By 4000 cal yr BP, lake levels rose to modern conditions at Jan Lake (Barber and Finney 2000). In the Birch Lake record, spruce abundance declined around 3000 cal yr BP, which is potentially linked to the further expansion of muskeg and peat bogs to their current ranges (Bigelow 1997).

Changes in technology occurred during the Middle Holocene. Anderson (1968, 1988) originally defined the Northern Archaic Tradition based on assemblages at the Onion Portage site that appeared different from those on the northwest coast, but were similar to those found in interior Alaska, the Yukon, and further south. Side-notched points are the defining feature of the tradition and appear in the interior Alaskan record after 6000 cal yr BP. The tradition also includes large choppers, lanceolate points, endscrapers, notched pebbles, and crescent-shaped bifaces. Some question the usefulness of such a broad and variable typology that also includes microblade and burin technology (Cook and Gillispie 1986; Esdale 2008; Potter et al. 2008b).

Some propose a relationship between the spread of the boreal forest and the adoption of the side-notched points in the Northern Archaic Tradition (Anderson 1968, 1988; Campbell 1961; Mason and Bigelow 2008). Others suggest similarities between Northern Archaic assemblages and Archaic assemblages from the southeastern United States (Workman 1978). Population replacement could account for the presence of Northern Archaic technology, with movement of southern populations up through the Yukon into the Brooks Range, extending to the area of Onion Portage, and then working their way south into the interior (Workman 1978). Morrison (1987) suggests a diffusion of notched projectile point technology from the south to the north in the Mackenzie Valley. Esdale's (2008) review of approximately 200 Northern Archaic sites identifies site clusters in mountainous areas. Overall, the explanation for the appearance of Northern Archaic technology in the Middle Holocene requires more research.

It is possible that slight fluctuations in environmental conditions due to several global-scale climatic events during the Middle Holocene compounded local-scale ecological changes that began in the Early Holocene. These global-scale climate events include cool or dry periods at 3800 cal yr BP and 2900 cal yr BP (Brigham-Grette 2001) and the Medieval Climatic

Anomaly at approximately 1500-1300 cal yr BP (Calkin et al. 2001). In addition, several regional volcanic events occurred during the Middle Holocene that impacted the distribution and abundance of floral and faunal resources. In turn, these changes likely influenced subsistence and settlement patterns of human populations in the region. These include the Oshetna (6750-5850 cal yr BP; Dixon 1993), the Hays series (4200 and 3800 cal yr BP; Begét et al. 1991; Riehle et al. 1990), and the White River Ash Northern and Eastern Lobes (1800 and 1140 cal yr BP, respectively; Lerbekmo 2008).

There are several difficulties associated with interpretation of the archaeological record dating to this period. Taphonomic mixing at Mead, Broken Mammoth, and Swan Point complicates component delineation. At Broken Mammoth, CZ 1b dates to approximately 5200 cal yr BP and CZ 1a to approximately 2500 cal yr BP (Holmes 1996). Mead CZ 1a likely dates to approximately 1330 cal yr BP (Potter et al. 2011b). At Swan Point, CZ 1a and 1b range between 1600 and 1100 cal yr BP (Holmes et al. 1996).

3.3.6 The Late Holocene (~1000 cal yr BP to present)

By approximately 1000 cal yr BP, subsistence and settlement patterns and associated technology drastically changed. The Little Ice Age occurred at approximately 900-200 cal yr BP and potentially impacted floral and faunal communities in interior Alaska (Calkin et al. 2001). Overpeck et al. (1997) suggest that variability in high-latitude environments has occurred over the past 400 years, which has implications of predictions of future change due to both anthropogenic and natural causes. Bison became extinct between 1000 and 400 years ago (Stephenson et al. 2001). The increase in moose abundance throughout the Late Holocene period may be linked to the expansion of the mesic taiga habitat (Guthrie 2006). The shift in faunal communities likely impacted human subsistence and settlement patterns. Table 3.1 summarizes the paleoenvironmental and archaeological change that occurred in interior Alaska from the Last Glacial Maximum to the Late Holocene.

The Late Prehistoric or Athabascan Period in the archaeological record has direct ties to ethnographic populations in interior Alaska (Cook 1975; Dixon 1985). Some suggest that the Athabascan Tradition was the result of in-situ development (Cook 1975), while others suggest that it occurred due to population migration into the region (Aigner et al. 1986). Others propose the Athabascan Tradition reflects subsistence strategies that primarily revolved around intensive

Table 3.1 Paleoenvironment and Archaeology in Interior Alaska. This table summarizes paleoenvironmental and archaeological change in interior Alaska from the Last Glacial Maximum to the Early Holocene, based on the discussion and references provided in the main text.

Period (cal yr BP)	Climate	Vegetation	Lake Levels	Fire History	Archaeology
Last Glacial Maximum (25,000 to 14,000)	Cooler than modern temperatures; arid; glacial advance; lower global sea-levels and exposed Bering Land Bridge	Mosaic of graminoid- and herbaceous-tundra; minor shrub-tundra component	Harding Lake formed but desiccated	?	No evidence of human occupation in interior Alaska at this point
Late Glacial Period (14,000 to 13,000)	Bølling-Allerød interstadial; warmer and/or wetter than modern	Shift in dominance from herbaceous- to shrub-tundra	Formation of lakes in interior Alaska; lower than modern levels	?	Early Diuktai-like assemblages; Denali and Nenana Complexes
Late Pleistocene/ Early Holocene Transition (13,000 to 11,500)	Younger Dryas; cooler and/or dryer	Continued dominance shrub-tundra communities with shrub-birch as a major component; reemergence of herb and grass vegetation communities in ecologically sensitive areas	Increase toward modern levels	Variable, likely less than modern	Denali and Nenana Complexes
Early Holocene (11,500 to 6000)	Holocene Thermal Maximum; increased seasonality; cooler than modern winters and warmer than modern summers; continued aridity	Spread of tree taxa such as *Populus*; development of open woodlands in interior Alaska, with continued importance of shrub-birch and willow	Increase toward modern levels	Low frequency and intensity of fires	Denali and Nenana Complexes
Middle Holocene (6000 to 1000)	Slight cooling	Development of the boreal forest; black spruce dominated landscape	Most lakes at or near modern levels	Increased fire frequency and intensity	Northern Archaic
Late Holocene (1000 to present)	Slightly cooler and moister conditions than previous paleoenvironmental periods	Vegetation communities reached modern conditions	Lakes at modern levels	Increased fire frequency and intensity	Athabascan Tradition

salmon exploitation and summer caribou hunting in upland areas (Potter 2008b). Storage features and residential sites became more common in the archaeological record. The bow and arrow replaced the atl'atl and dart system (Hare et al. 2004). Both ethnographic and ice patch data suggests spruce and birch continued as important sources of raw material for bows and arrows (Alix et al. 2012; VanderHoek et al. 2012). Copper and organic technologies increased in importance with the decline of formal chipped stone technology and microblades in the record (Cooper 2007; Potter 2008b; Shinkwin 1979; Workman 1978).

Chapter 4

Modeling Plant Resource Use in Interior Alaska

Archaeobotanists apply a range of methods and theories to address plant resource use by prehistoric foragers (see Marston et al. 2014). This thesis uses optimal foraging and risk avoidance models as heuristic tools to explore research questions relating to site seasonality, plant resource use, land use, and deposition and taphonomy. The first section in this chapter describes the theory, objectives, and assumptions of the model developed in this thesis. The second section describes the expectations of archaeobotanical assemblage characteristics (content, density, diversity, and ubiquity) for Late Pleistocene and Holocene interior Alaskan sites. Although I address questions related to site-specific research at Upward Sun River, future research can build on the model expectations in order to incorporate plant resource use into a holistic understanding of prehistoric foraging behavior in interior Alaska.

4.1 The Model

In this research, I argue that archaeobotanical assemblage characteristics vary based on site function, occupants, seasonality, and length of occupation, in addition to regional changes in vegetation over time. Although the model focuses on hearth features, the final analysis from the Upward Sun River site includes two mortuary features for comparative purposes. The model organizes expectations of plant resource and land use into an annual framework. Within a year, a forager may have chosen to alter subsistence and settlement practices based on day-to-day and seasonal fluctuations in resource availability. With this model, I aim to address the assumption that arctic and subarctic foragers primarily depended on animal resources and the proteins and fats that they offer in order to maintain fitness (see Chapter 1 and discussions in Marlowe 2007, Speth 2010, and Waguespack 2005).

Humans require a balance of micro- (vitamins, minerals, organic acids) and macro- (proteins, fats, carbohydrates) nutrients to maintain physiological health (NAS 2011). Model expectations incorporate nutritional information for interior Alaskan floral and faunal resources to address nutrient deficiencies that could occur in a diet rich in animal foods (Kuhnlein and Turner 1991; Nobmann 1993; USDA 2015). In particular, I consider seasonal availability of resources and explore the ways in which prehistoric foragers could have met daily nutritional demands throughout the year.

One assumption associated with this model is that the distribution of plant resources observed today in interior Alaska was similar in the past, unless paleoecological records suggest otherwise (see Ager and Brubaker 1985; Anderson and Brubaker 1993; Anderson et al. 2004; Bigelow 2013; Zazula et al. 2006a). Ecological literature informs on the seasonal availability of plant taxa (Hultén 1968; Viereck and Little 2007), in addition to ethnographic and modern records of wild plant and game resource use (Halpin 1987; Kari 1985; Kuhnlein and Turner 1991; Shinkwin and Case 1984). Appendix B provides more information and references for the plant and animal taxa mentioned throughout the model.

Establishing the presence of floral and faunal taxa on the landscape is difficult due to taphonomic problems and insufficient sampling. Similar to archaeobotanical assemblages, factors such as screen size, sample size, post-depositional disturbance, and scavenging influence zooarchaeological assemblages, in addition to human processing and transportation strategies (Casteel 1972; Grayson 1989; Lyman 1994). However, this model does not aim to predict the exact composition of floral and faunal assemblages, but rather to provide a range of taxa that could be present, given ideal preservation conditions. If the results do not meet the model expectations, then factors such as taphonomy and cultural preference can be considered.

The diet breadth and risk avoidance models guide expectations of seasonal foraging behavior in this model. The diet breadth model assumes that foragers always exploit higher over lower ranked resources (Broughton and O'Connell 1999; Smith 1983). Diet breadth broadens to include lower ranked resources if encounter rates for higher ranked resources decreases, while diet specialization occurs when high ranked resources become more abundant (Broughton and O'Connell 1999; Smith 1983). This model does not rank resources based on return rates. Instead, it considers the nutritional value of resources relative to recommended daily requirements. Assemblage diversity serves as a proxy measure for diet breadth and ubiquity as a proxy measure for dietary specialization or generalization.

This model also assumes that daily nutritional requirements defined by NAS (2011) apply to prehistoric foragers and that the nutritional content of plant and animal resources available in the past was similar to their modern day values. Recommended nutrient intakes vary based on age, sex, activity level, and environment (NAS 2011). Pregnancy also impacts recommended nutrient intakes. This model uses the average recommended daily values for adults 19-30 years old as proposed by NAS (2011) for comparison with the nutrients offered by plant and animal

foods. The nutritional values discussed in this thesis come from wild plants and game animals (Kuhnlein and Turner 1991; Nobmann 1993; USDA 2015), rather than domesticated or cultivated varieties, which serve as proxies for prehistoric plant and animal nutrient content.

Modern studies and ethnographic records suggest seasonal variability in nutrient content for plant and animal resources. For example, ethnographic records describe the fall season as ideal for hunting moose because they are "fat" from steady food intake throughout the summer months (Halpin 1987: 32). Alternatively, large mammals hunted in spring months are valued less due to depleted fat reserves (Halpin 1987). In terms of plant resources, recent food chemistry research suggests that plant nutrients decrease during ripening, in addition to during processing and cooking activities (Castrejón et al. 2008; Howard et al. 1999; Nicoli et al. 1999; Rekha et al. 2012). With the expectations developed here, I consider the seasonal differences in the nutrient content of food resources and assume that Late Pleistocene and Holocene foragers experienced an annual period of resource scarcity during the late winter and early spring months.

The ethnographic record notes the importance of stored plant and famine foods during periods of resource stress (Halpin 1987; Holloway and Alexander 1990; Jones 2010; McKennan 1959; Shinkwin and Case 1984; Turner and Davis 1993). Turner and Davis (1993) define famine foods as those used minimally during normal times, but which become increasingly important in times of resource stress. Although some studies suggest that humans cannot digest lichens, they are a common example of a famine food (Crawford 2001). Arctic and subarctic ethnographic populations usually process lichens by boiling them, which captures digestible carbohydrates that would otherwise be lost (Crawford 2001; Kuhnlein and Turner 1991). In addition, some groups gathered partially digested lichens from stomach of caribou, which are often mixed with fat or bone marrow for consumption (Osgood 1937).

Although evidence of storage does not appear in the archaeological record until the Middle Holocene (Potter 2008b; Shinkwin 1979), Late Pleistocene and Early Holocene foragers were likely aware of seasonal variability in plant and animal resources and may have altered foraging behavior to accommodate the differences. The high degree of residential mobility expected for Late Pleistocene and Early Holocene foragers (Potter 2008a) likely necessitated the preservation of food resources in a transportable manner, which may not be archaeologically visible.

For example, the ethnographic record notes traditional practices for berry preservation that likely would not result in archaeological remains. In general, the process includes mixing berries with fat (moose, sheep, bear, or fish oil) and storing the mixture in birch-bark baskets, animal skins, or sewn stomach sacs (Halpin 1987; Holloway and Alexander 1990; Jones 2010; Kari 1985). Ethnographers note the addition of dried meat or fish to the mixture to make "Indian hash" (Holloway and Alexander 1990: 218) or "Eskimo Ice Cream" (Jones 2010: 189). Foraging populations often reserved the mixture for special occasions or travel (Jones 2010). Speth (2010: 73) notes the cross-cultural occurrence of this mixture, commonly referred to as pemmican. Early explorers, fur-trappers, colonists, and military personnel adopted the meal when they noticed the "protein poisoning" (Stefansson 1944: 234) associated with purely lean-meat diets, which can lead to starvation and eventually death (Speth 2010).

The trends outlined in the ethnographic record relate to the concept of risk, which the model incorporates into expectations of foraging behavior (Figure 4.1). Day-to-day risk relates to foraging for higher-return, but less predictable resources. Ethnographic research suggests day-to-day risk associated with low success rates for men's hunting is often mitigated by women's contribution of predictable, low-return resources to the diet (Bird 1999; Kelly 2013). The presence of lower-return plant resources at a site suggests foragers included these predictable resources in their diet to mitigate the risk associated with large mammal hunting. Seasonal fluctuations in resource availability define another level of risk. A broader diet breadth that includes lower ranked, predictable, and storable resources reflects mitigation of risk associated with seasonal fluctuation in resource availability (Kelly 2013).

In this research, I suggest that women's foraging behavior may have impacted subsistence and settlement practices throughout the Late Pleistocene and Holocene, in addition to male-oriented foraging behavior. Anthropologists debate the origin and function of the gender division of labor in foraging societies (Bird 1999; Hawkes 1990; Hawkes and Bliege Bird 2002; Lancaster and Lancaster 1983; Lovejoy 1981; Smith 2004). Traditional views assume that males and females target different resources that they share to maintain fitness and increase foraging efficiency for the group (Lancaster and Lancaster 1983; Lovejoy 1981). Other researchers suggest conflict between males and females, who forage to maximize their own reproductive fitness rather than the household's (Bird 1999; Hawkes 1990; Hawkes and Bliege Bird 2002; Smith 2004).

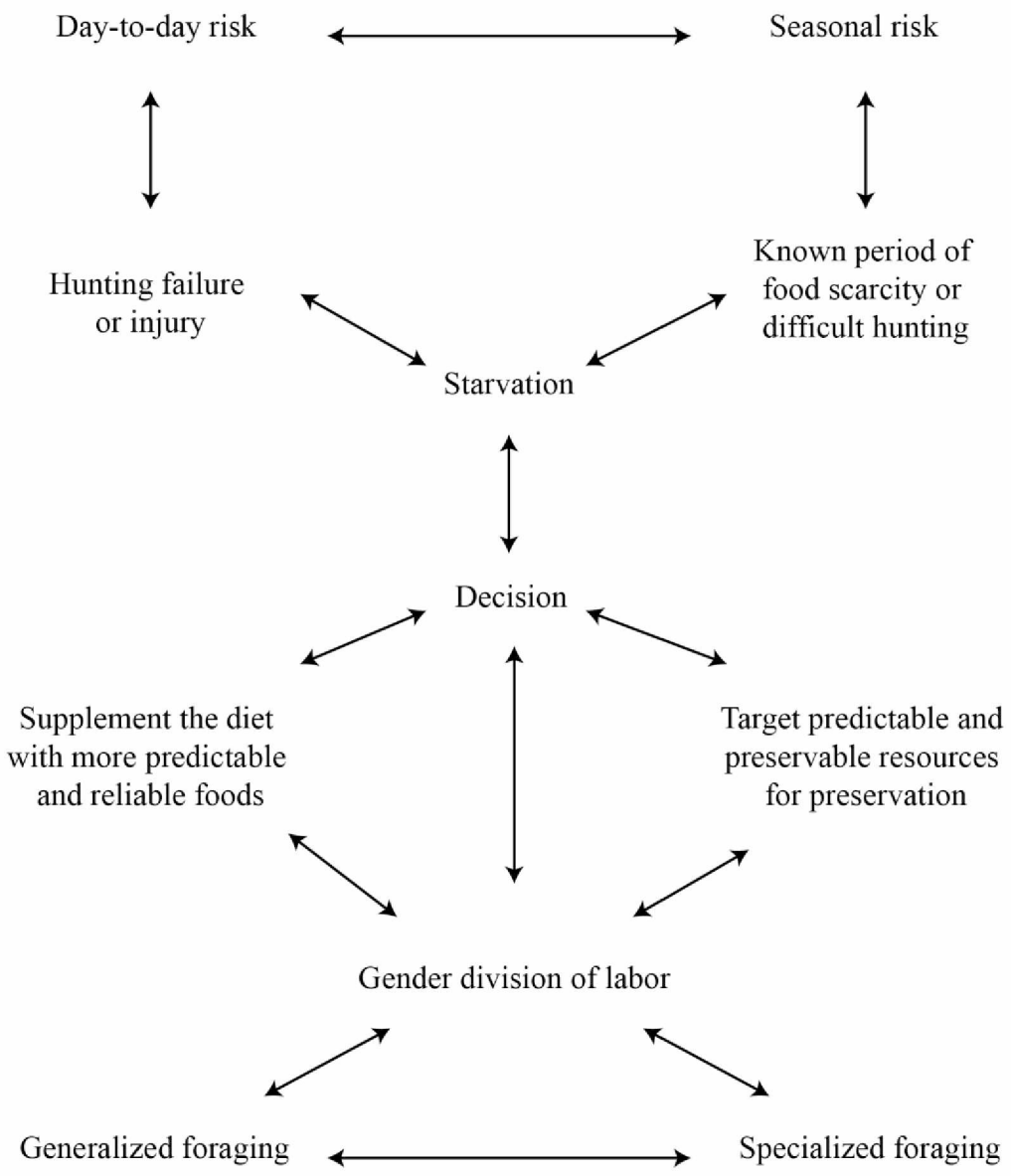

Figure 4.1 Foraging Decisions. This figure illustrates decision making associated with risk mitigating behavior. Late Pleistocene and Holocene foragers likely experienced varying and connected day-to-day and seasonal risk that could be better met with flexibility in behavior and land use strategies.

Male and female contributions to subsistence may vary seasonally, creating flexibility in resource procurement and processing (Jochim 1988). The costs and benefits associated with resource exploitation differ between males and females (Jochim 1988). For example, inadequate nutrition may impact female fitness and early child development more than male fitness, which could influence overall population fitness. As a result, women may make more effort to avoid energy-demanding and risky foraging strategies, which could be reflected in decisions to forage closer to camp. Overall, the ethnographic record suggests that northern groups divide tasks rather than resources, with women engaging less in food procurement and more on processing and domestic activities (Jochim 1988; Marlowe 2007).

In archaeological research, equating women's activities to plant gathering and using the amount of plant foods present in a record as a proxy for overall contribution to subsistence reduces the importance of women in these systems (Marlowe 2007; Waguespack 2005). Archaeologists should incorporate activities such as food processing, clothing manufacture, and gathering non-food materials (such as fuel) into reconstructions of past lifeways to gain fuller understanding of the gender division of labor (Halperin 1980; Waguespack 2005). This model assumes that Late Pleistocene and Holocene foragers in interior Alaska mitigated seasonal risk by targeting predictable resources for preservation. Women may have supplied the bulk of plant resources to the site occupants' diet, given the patterns outlined in the ethnographic literature, while also engaging in other domestic activities that are not as visible in the archaeological record (such as hide processing).

In addition, model expectations relate site type and archaeobotanical assemblage characteristics. Site types include base camps associated with longer-term occupations and special-purpose sites usually associated with shorter-term occupations and hunting. This model draws on Bonzani's (1997) expectations of diversity and ubiquity for different site types in order to consider the impact of plant resource exploitation on land use practices. Central place foraging relates to models of land use and considers foragers that consistently return to the same base camp after foraging. This model assumes that plant resources were collected within a close proximity to the central camp. This would necessitate the placement of the base camp in a location with access to multiple resources, particularly those that are difficult to transport (such as water) in addition to plant resources.

This research draws from sources such as Glassburn (2015), Holmes (2001), Potter (2007, 2008b, 2011), Potter et al. (2013), Shinkwin and Aigner (1979), and Yesner (1996, 2001, 2007) to consider temporal variation in land use and resource availability for interior Alaska during several periods: Late Glacial period (~14,000 to 13,000 cal yr BP), the Late Pleistocene to Early Holocene transition (~13,000-11,500 cal yr BP), the Early Holocene (~11,500-6000 cal yr BP), the Middle Holocene (~6000 to 1000 cal yr BP), and the Late Holocene (~1000 cal yr BP to present). Although the components examined from the Upward Sun River site date to the Late Pleistocene and Early Holocene, this model encompasses a broad temporal scale for comparison and future application of model expectations to sites of varying age in interior Alaska.

4.2 Expectations

The ethnographic record often describes the division of seasons based on observed annual occurrences in the ecosystem such as the timing of freeze-up and break-up, changes in the length of daylight, the arrival of salmon runs, and green-up (Andrews 1975; Halpin 1987). In addition, many interior Alaskan archaeologists note seasonal variation in site function, technology, and associated foraging activities (Holmes 2001; Potter et al. 2013; Yesner 2007). This model outlines expectations of archaeobotanical assemblage content with features and components as units of analysis for four seasons relating to the timing of freeze-up and break-up: summer (June through August), fall (September through October), winter (November through March), and spring (April and May).

4.2.1 Summer (June through August)

In interior Alaska, summer (June through August) is a time of resource abundance. Lithic and faunal evidence from Late Glacial archaeological components suggest a broad diet breadth, including bison, wapiti, small mammals, and waterfowl (Holmes 2001; Potter 2011; Potter et al. 2013; Yesner 2001). Archaeologists propose flexibility in land use and mobility during the Late Glacial through the Early Holocene, with a generalized emphasis on residential mobility, lowland settings, and bison and wapiti procurement (Glassburn 2015; Potter et al. 2013; Yesner 2007). A summer division of labor with residential base camps in lowland, ecotone settings and logistical hunting camps in uplands for bison procurement would allow for the input of a greater diversity of resources into forager diets (Glassburn 2015).

Environmental change during the Younger Dryas could have led to resource stress due to decreased abundance of bison and wapiti (Potter et al. 2013; Yesner 2001, 2007). In interior Alaska, transitional Late Pleistocene and Early Holocene components contain evidence of small mammals, waterfowl, and fish in addition to bison and wapiti, suggesting increased diet breadth (Holmes 2001; Potter et al. 2013; Yesner 2001, 2007). If habitat reduction affected access to large mammals, then there was likely greater reliance on plant resources in addition to low-return animals. The increase in diet breadth could also be related to an expansion of wetland waterfowl habitats, which served as a seasonally predictable resource (Yesner 1996). By the Early Holocene, large mammals may have become more abundant, thereby decreasing the reliance on low-return resources (Potter et al. 2013).

During the Middle and Late Holocene, there was a shift from generalized to specialized subsistence strategies as foragers focused on seasonally abundant and predictable resources such as caribou and salmon (Potter 2008b). Potter (2008b) notes that sites become more common in riverine and lacustrine settings and suggests foragers spent summers in longer-term residential camps oriented around fishing locations, from which logistically organized groups branched out to hunt for large mammals. Seasonally abundant plant resources likely became more important throughout the Middle and Late Holocene. To accommodate practices of processing and storage such as caching, the seasonal round likely became more rigid and structured.

During the summer, Tanana Athabascan bands regrouped at summer fishing camps near the outlets of lakes and areas that experienced the heaviest fish runs (Andrews 1975; Hosley 1981; Olson 1968; Vitt 1971). These locations were reoccupied for several years, served as base camps, and were usually no more than 10 miles away from major resources (Shinkwin and Aigner 1979; Shinkwin et al. 1980). In June and July, the Tanana exploited whitefish and salmon during their runs up clear-water rivers (Hosley 1981; McKennan 1981). Fish were cut, dried, and stored for the coming winter months (Andrews 1975; Olson 1968). By late summer, hunting trips to the foothills of the Brooks and Alaska Ranges for sheep took place, while women snared small game (Hosley 1981; McKennan 1981). Berries and roots were gathered throughout the summer to supplement the diet, typically within two miles of the base camp (Andrews 1975; Halpin 1987; McKennan 1981; Shinkwin and Case 1984).

Building on previous models of subsistence and land use for interior Alaska, this model considers the summer as a time of opportunistic foraging for abundant, locally available plant

resources around a base camp. Foragers may have behaved in fitness maximizing ways, looking for plant foods with high nutrient content, while ignoring foods typically only gathered during periods of starvation. During the Late Glacial through the Early Holocene, foragers may have oriented base camps around ecotones in order to take advantage of a wide array of resources, while later during the Middle and Late Holocene summer base camps were likely situated around fishing locations.

Based on these assumptions, an archaeobotanical assemblage deposited during the summer at a base camp should contain a greater diversity and density of macrobotanical remains than a task-specific hunting camp, suggesting longer occupations, return to the same central location, and repeated use of hearth features. If a task-specific camp contains an archaeobotanical assemblage, it likely represents opportunistic foraging and immediate consumption events while hunting and processing higher-return animal resources for transport back to a base camp. Table 4.1 outlines the expected summer assemblage characteristics.

Table 4.2 lists plant taxa that could appear in an interior Alaskan site produced during the summer. For plant resources, young leaves, greens, and shoots from species such as roseroot stonecrop (*Sedum rosea*), alpine mountain sorrel (*Oxyria digyna*), mountain bistort (*Polygonum*

Table 4.1 Expected Summer Assemblage Characteristics. This table lists generalized expectations of summer assemblage characteristics for different site types discussed in the main text (modified from Bonzani 1997), assuming opportunistic and fitness maximizing behavior. Chapter 5 defines archaeobotanical density, diversity, and ubiquity as low, medium, or high.

	Base Camp	**Task-Specific Camp**
Density	High	Low
Diversity		
Feature	High	Low
Component	High	Low
Ubiquity	High	High
Content	Perishable, nutrient-rich, and seasonally abundant taxa; storable foods possible	Perishable, nutrient-rich, and seasonally abundant taxa
Inferred Behavior	Opportunistic foraging and immediate consumption; processing and preserving possible	Opportunistic foraging and immediate consumption

Table 4.2 Expected Summer Floral Resources. This table lists the floral resources expected in an archaeobotanical assemblage produced in the summer. Known presence refers to when the taxa appears in paleoenvironmental records (Bigelow 2013; Bigelow and Edwards 2001; Potter et al. 2011a; Zazula et al. 2006a). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, and LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation (Kari 1985; Kuhnlein and Turner 1991).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Betula glandulosa	Dwarf birch	LGM (genus)	
Betula neoalaskana	Paper birch	EH (genus)	
Alnus spp.	Alder	EH (genus)	
Viburnum edule	High-bush cranberry	No data	Yes
Cornus canadensis	Bunchberries	No data	
Sedum rosea	Roseroot	No data	
Juniperus communis	Mountain juniper	EH (genus)	
Shepherdia canadensis	Soapberry	LGM (species)	Yes
Equisetum arvense	Horsetail	LG (genus)	
Arctostaphylos uva-ursi	Common bearberry	LG (species)	Yes
Arctous spp.	Red-fruit and alpine bearberry	LG (genus)	
Ledum spp.	Labrador Tea	LGM (family)	
Oxycoccus microcarpus	Bog cranberry	LGM (family)	Yes
Vaccinium spp.	Blueberry/low-bush cranberry genus	LP/EH (genus)	Yes
Hedysarum alpinum	Wild potato	LP/EH (genus)	Yes
Allium schoenoprasum	Wild chive	No data	Yes
Epilobium spp.	Fireweed	LGM (genus)	
Picea spp.	White and black spruce	EH (genus)	
Oxyria digyna	Mountain sorrel	LGM (genus)	
Polygonum bistorta	Mountain bistort	LGM (genus)	Yes
Rumex arcticus	Sour dock	LGM (genus)	
Athyrium filix-femina	Lady fern	No data	
Dryopteris expansa	Spiny wood fern	LG (genus)	
Amelanchier alnifolia	Serviceberry	LP/EH (genus)	
Fragaria virginiana	Wild strawberry	LGM (family)	
Potentilla sp.	Cinquefoil	LGM (genus)	Yes
Rosa acicularis	Prickly rose	LGM (genus)	
Rubus spp.	Raspberry genus	LGM (genus)	
Populus spp.	Balsam poplar or aspen	EH (genus)	
Salix spp.	Willow	LGM (genus)	
Ribes sp.	Currant	LGM (genus)	
Typha latifolia	Cattail	LGM (genus)	Yes

bistorta), arctic sourdock (*Rumex arcticus*), fireweed (*Epilobium* spp.), and common cattail (*Typha latifolia*) are ready for harvest during this season and make important contributions to subsistence practices detailed in both ethnographic and modern records (Kari 1985; Kuhnlein and Turner 1991).

Some berry species ripen earlier in the summer, such as wild strawberries (*Fragaria virginiana*), currants (*Ribes* spp.), Saskatoon serviceberries (*Amelanchier alnifolia*), and some species in the raspberry genus (*Rubus* spp.), which make important contributions to dietary diversity recorded in ethnographic and modern records (Kuhnlein and Turner 1991; Viereck and Little 2007). Taxa such as alpine buckler fern (*Dryopteris expansa*) and lady fern (*Athyrium filix-femina*) are also available in this season, though the ethnographic record notes their harvest in spring and fall seasons (Garibaldi 1999; Kari 1985; Osgood 1937; Viereck 1987).

In terms of animal resources (Table 4.3), bison and wapiti may have provided the bulk of summer animal resources during the Late Glacial, Late Pleistocene and Early Holocene transition, and Early Holocene. However, large mammal availability may have declined during the Younger Dryas at the transition from the Late Pleistocene and Early Holocene (Potter et al. 2013), during which time foragers likely turned to lower-return small mammals, waterfowl, fish, and plants to maintain fitness (Potter et al. 2013). Yesner (2007) suggests that migratory waterfowl and fish could be taken throughout the summer. Evidence from the Early Holocene suggests less emphasis on lower-return resources and fish are absent from the record, though this may be a reflection of taphonomic and sampling biases (Potter et al. 2013). During the Middle and Late Holocene, foragers may have focused their efforts on the procurement of fish and waterfowl during the summer. The ethnographic record also reports Dall sheep hunting in the late summer before the fall caribou migrations (Andrews 1975; Halpin 1987; Haynes and Simeone 2007; Hosley 1981; McKennan 1959).

Based on the seasonal expectations of resource availability, this model develops generalizations regarding the potential nutrient input into the summer diet. The charts of selected summer plant and animal resource contribution (per 100 g) to average recommended daily intakes for adults aged 19-30 years display several trends (Figures 4.2 and 4.3). Bison provide ~40% of recommended daily protein intake and ~20% of the daily fat allowance for adults 19-30 years of age. Coho salmon, wild rabbit, ruffed grouse, and ground squirrel provide a similar percentage of protein to the diet, though they are less rich in fat. Summer animal resources

contribute less than 10% of calcium and Vitamins A and C, and do not contribute fiber or carbohydrates to the diet. Foragers would have had access to a variety of nutrients from the organs of fresh kills during the summer (the nutritional values are discussed in the fall section).

Alternatively, some of the plant resources available in the summer provide Vitamin C, with fireweed leaves and cloudberries contributing 100% of the daily recommended intakes, in addition to other micro-nutrients such as niacin, riboflavin, and thiamine. Plant foods generally contribute less than 10% of recommended daily caloric, protein, and fat intakes. Overall, the plants and animals expected in summer assemblages contribute minimally to recommended daily intakes for minerals such as potassium and sodium.

Table 4.3 Expected Summer Faunal Resources. This table lists the faunal resources expected in a summer occupation. Known presence refers to when the taxa appears in paleoenvironmental or archaeological records (Guthrie 2006; Potter 2008b; Potter et al. 2013). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, and LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation in the ethnographic or archaeological record (Andrews 1975; Potter et al. 2013; Shinkwin and Case 1984).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Bison sp.	Bison	LGM to LH	Yes
Cervus elaphus	Wapiti or elk	LGM to EH	Yes
Alces alces	Moose	LP/EH	Yes
Ovis dalli	Dall sheep	LGM	Yes
Lepus americanus	Snowshoe hare	LGM	Yes
Spermophilus spp.	Ground squirrel	LMG	Yes
Lutra canadensis	River otter	LG	Yes
Marmota spp.	Marmot	LG	Yes
Castor canadensis	Beaver	LP/EH	Yes
Ursus sp.	Black and brown bear	LG	Yes
Birds	Grouse, ptarmigan, waterfowl	LG	Yes
Anadromous fish	Salmon	LP/EH	Yes
Freshwater fish	Whitefish, grayling, burbot, pike	LG	Yes

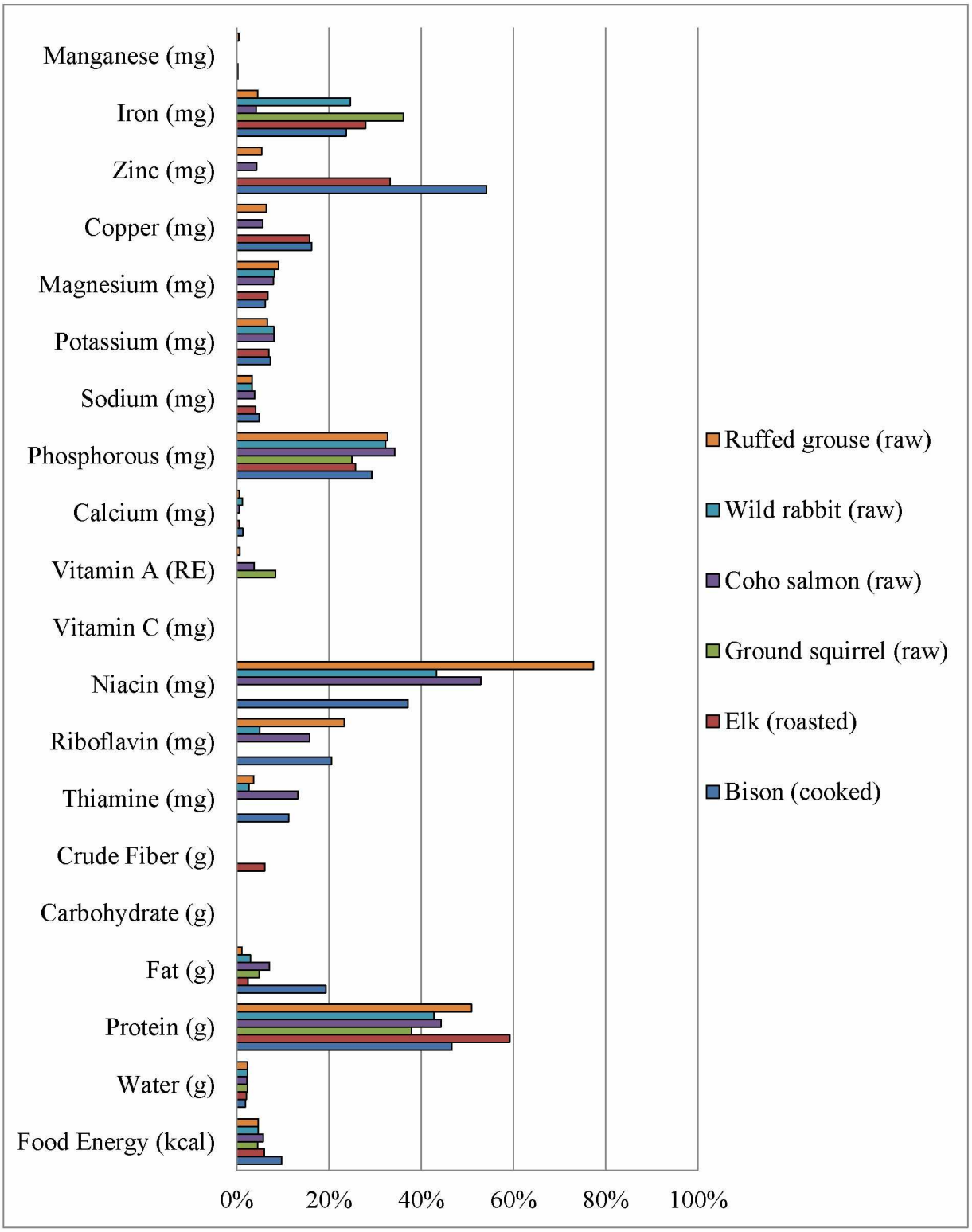

Figure 4.2 Summer Animal Nutrients (Adults 19-30 yr). This chart illustrates the percent contribution of select animal foods (100 g) to average recommended daily nutrient intakes for adults aged 19-30 years (NAS 2011; USDA 2015).

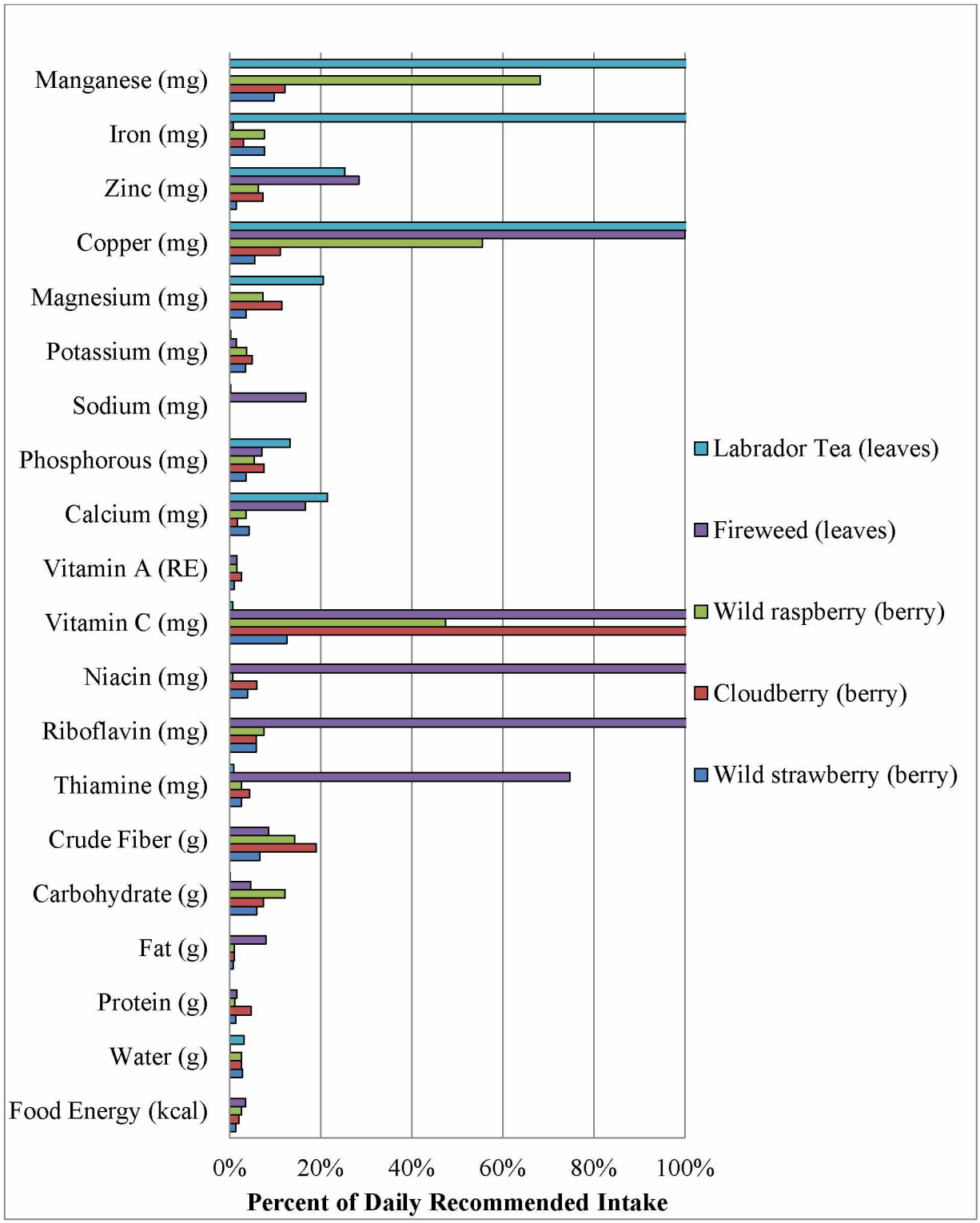

Figure 4.3 Summer Plant Nutrients (Adults 19-30 yr). This chart illustrates the percent contribution of select plant foods (100 g) to average recommended daily nutrient intakes for adults aged 19-30 years (NAS 2011; USDA 2015).

4.2.2 Fall (September through October)

Fall (September through October) is a productive season for the boreal forest of interior Alaska, as many highly sought after and culturally important berry species ripen (Kari 1985; Viereck and Little 2007). Similar to the summer season, bison and wapiti hunting may have occurred in logistically organized hunting camps during the fall season throughout the Late Glacial and into the Early Holocene (Glassburn 2015; Yesner 2007). Migrating bison and wapiti herds could be intercepted as they left their summer feeding grounds in the Alaska Range and the Yukon-Tanana Upland to overwinter in lowlands of the Tanana River Valley (Yesner 2007). Foragers may have organized residential base camps around productive ecotones to access a variety of resources (Glassburn 2015). During the Middle and Late Holocene, the fall season was likely a time of caribou hunting in upland settings (Potter 2008b), similar to seasonal activities described in the ethnographic record (Andrews 1975).

The ethnographic record describes fall as a season of preparation for the winter months, although summer resources such as salmon were dried and cached as soon as they became available (Andrews 1975; Halpin 1987; Shinkwin and Case 1985). Fishing activities carried over into September while moose and Dall sheep were hunted (Andrews 1975). The fall caribou migration from mid-October through November was important to groups in the Tanana River basin (Andrews 1975; Hosley 1981; McKennan 1981; Olson 1968; Vitt 1971). By late September, fishing camps dispersed to gather near caribou fences in the Yukon-Tanana Upland, where they corralled caribou with snares and bows and arrows (McKennan 1981). Winter camps remained in these locations and the caribou drive generally provided enough meat to last through the winter when supplemented with fish (McKennan 1981; Vitt 1971).

This model develops general expectations of fall plant resource use, with regard to previous models of seasonal foraging behavior. Some opportunistic foraging may have occurred during the fall, though foraging activities probably focused on avoiding the risk of starvation in winter months. A fall central base camp should contain a medium-density archaeobotanical assemblage dominated by predictable and storable resources. Nutrient-rich resources that were present, but not abundant enough to warrant preservation and storage, may also comprise a small portion of the assemblage. Fall components should contain evidence of task-specific areas related to preservation and storage of resources, resulting in a low ubiquity value for plant taxa and low diversity values for individual features.

Fall archaeobotanical assemblages are less likely at special-purpose camps. Associated archaeobotanical evidence should relate to immediate consumption events of a low diversity of taxa, resulting in a low density for the assemblage. The assemblage should have high ubiquity values for any taxa present, as this model does not expect task-specific processing areas for this site type. Table 4.4 outlines these expectations.

Table 4.5 and 4.6 list the floral and faunal taxa expected to appear in a fall occupation. Several culturally and economically important berry species ripen during the late summer and fall, such as crowberry, common bearberry, soapberry (*Shepherdia canadensis*), blueberry and low-bush cranberry (*Vaccinium* spp.), high-bush cranberry, and species from the currant (*Ribes* spp.) and raspberry families (Kari 1985; Kuhnlien and Turner 1990). If autumn foraging activities focused on risk mitigation, then storable plant taxa should comprise the majority of an archaeobotanical assemblage produced during this season. This category mainly includes berry taxa, which can be preserved through drying or mixing with animal grease or fat in the manner described earlier in this chapter. The ethnographic record often mentions common bearberries, blueberries, and cranberries in association with preservation and storage, in addition wild potato (*Hedysarum alpinum*) and cinquefoil (*Potentilla* spp.) roots (Holloway and Alexander 1990; Jones 2010; Kari 1985).

Table 4.4 Expected Fall Assemblage Characteristics. This table lists generalized expectations of fall assemblage characteristics for different site types discussed in the main text (modified from Bonzani 1997), assuming risk mitigating behavior. Chapter 5 discusses classification of assemblage characteristics as low, medium, or high.

	Base Camp	**Task-Specific Camp**
Density	High	Low
Diversity		
Feature	Low to medium	Low
Component	Medium	Low
Ubiquity	Low	High
Content	Dominance of seasonally predictable, storable plant taxa; perishable, nutrient-rich taxa possible	Perishable, nutrient-rich, and seasonally abundant taxa
Inferred behavior	Risk avoidance; processing and preserving	Opportunistic foraging and immediate consumption

Table 4.5 Expected Fall Floral Resources. This table lists the floral resources expected in an archaeobotanical assemblage produced in the fall. Known presence refers to when the taxa appears in paleoenvironmental records (Bigelow 2013; Bigelow and Edwards 2001; Potter et al. 2011a; Zazula et al. 2006a). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, and LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation (Kari 1985; Kuhnlein and Turner 1991).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Betula glandulosa	Dwarf birch	LGM (genus)	
Betula neoalaskana	Paper birch	EH (genus)	
Alnus spp.	Alder	EH (genus)	
Viburnum edule	High-bush cranberry	No data	Yes
Cornus canadensis	Bunchberries	No data	
Juniperus communis	Mountain juniper	EH (genus)	
Shepherdia canadensis	Soapberry	LGM (species)	Yes
Elaeagnus commutata	Silverberry	LP/EH (genus)	
Equisetum arvense	Horsetail	LG (genus)	
Empetrum nigrum	Crowberry	LP/EH (order)	Yes
Arctostaphylos uva-ursi	Common bearberry	LG (species)	Yes
Ledum spp.	Labrador Tea	LGM (family)	
Oxycoccus microcarpus	Bog cranberry	LGM (family)	Yes
Vaccinium spp.	Blueberry/low-bush cranberry genus	LP/EH (genus)	Yes
Hedysarum alpinum	Wild potato	LP/EH (genus)	Yes
Allium schoenoprasum	Wild chive	No data	Yes
Epilobium spp.	Fireweed	LGM (genus)	
Picea spp.	White and black spruce	EH (genus)	
Athyrium filix-femina	Lady fern	No data	
Dryopteris expansa	Spiny wood fern	LG (genus)	
Amelanchier alnifolia	Serviceberry	LP/EH (genus)	
Potentilla spp.	Cinquefoil	LGM (genus)	Yes
Rosa acicularis	Prickly rose	LGM (genus)	
Rubus spp.	Raspberry genus	LGM (genus)	
Populus spp.	Balsam poplar and aspen	EH (genus)	
Salix spp.	Willow	LGM (genus)	
Ribes sp.	Currant	LGM (genus)	

Table 4.6 Expected Fall Faunal Resources. This table lists the faunal resources expected in a fall occupation. Known presence refers to when the taxa appears in paleoenvironmental or archaeological records (Guthrie 2006; Potter 2008b; Potter et al. 2013). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, and LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation in the ethnographic or archaeological record (Andrews 1975; Potter et al. 2013; Shinkwin and Case 1984).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Bison sp.	Bison	LGM to LH	Yes
Cervus elaphus	Wapiti/elk	LGM to EH	Yes
Rangifer tarandus	Caribou	LGM	Yes
Alces alces	Moose	LP/EH	Yes
Ovis dalli	Dall sheep	LGM	Yes
Lepus americanus	Snowshoe hare	LGM	Yes
Spermophilus spp.	Ground squirrel	LMG	Yes
Lutra canadensis	River otter	LG	Yes
Marmota spp.	Marmot	LG	Yes
Castor canadensis	Beaver	LP/EH	Yes
Ursus sp.	Black and brown bear	LG	Yes
Birds	Grouse, ptarmigan, waterfowl	LG	Yes
Fur-bearers	Muskrat, marten, wolverine, lynx, red fox	LG	Yes
Anadromous fish	Salmon	LP/EH	Yes
Freshwater fish	Whitefish, grayling, burbot, pike	LG	Yes

Other species may be present, such as wild chive or onion (*Allium schoenoprasum*), bog cranberry (*Oxycoccus microcarpus*), nagoonberry (*Rubus arcticus*), bunchberry (*Cornus canadensis*), and silverberry (*Elaeagnus commutata*), though these generally do not occur in great enough quantity to warrant storage (Kari 1985; Kuhnlein and Turner 1991). Their presence in an assemblage likely represents immediate consumption events. Rosehips (*Rosa acicularis*) also ripen in the fall, though they are available on the plant throughout the winter.

Similar to summer assemblages for the Late Pleistocene and Early Holocene, bison and wapiti likely made up the majority of fall animal resources for foragers during this period (Glassburn 2015; Potter 2008b). Other input may have come from small mammals, waterfowl, and fish, though with decreased importance for Early Holocene components (Potter et al. 2013). Waterfowl may have been taken in the fall, but Yesner (2007) suggests that spring was likely more important. Fish could be taken in summer or autumn, while small game could be taken year-round (Yesner 1996). For Middle to Late Holocene components, the greatest input of animal resources into the diet in the fall was likely caribou, in addition to salmon, moose, Dall sheep, waterfowl, and some small mammals (Potter 2008b).

Many of the trends observed with the nutritional contribution of bison, small mammals, birds, and salmon apply to the fall season in addition to the summer, though with caribou and moose contributing more to the diet during the Middle and Late Holocene (Figure 4.4). In addition to the protein and fat contained in the meat of these large mammal resources, organs also provide a wide variety of micro- and macro-nutrients. For example, caribou and moose liver provide 100% of the daily recommended intake for Vitamin A, in addition to large percentages of iron, copper, and riboflavin. Bison and wapiti organs could contribute similarly to micro- and macro-nutrient recommended daily intakes, but these data were not available for comparison. A forager would have access to these organs whenever they had access to a fresh kill.

For plants, root foods provide approximately 20% of recommended carbohydrate intake and the common bearberry provides over half of the recommended daily fiber intake (Figure 4.5). The plant resources also provide minerals such as zinc, manganese, and copper. During the fall season, the main deficiency in nutrient input was likely micro-nutrients such as potassium, magnesium, sodium, and calcium.

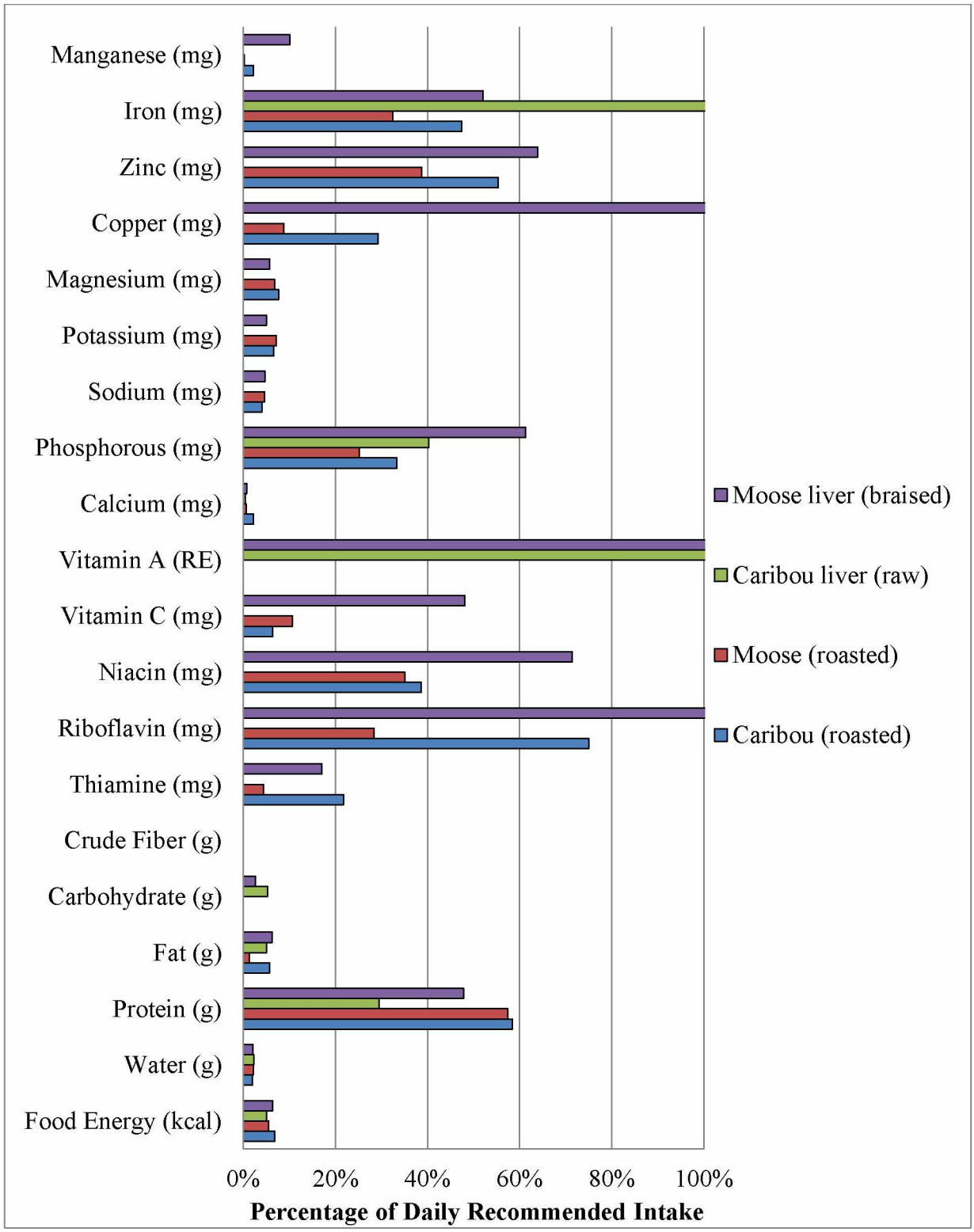

Figure 4.4 Fall Animal Nutrients (Adults 19-30 yr). This chart illustrates the percent contribution of select animal foods (100 g) to average recommended daily nutrient intakes for adults aged 19-30 years (NAS 2011; USDA 2015).

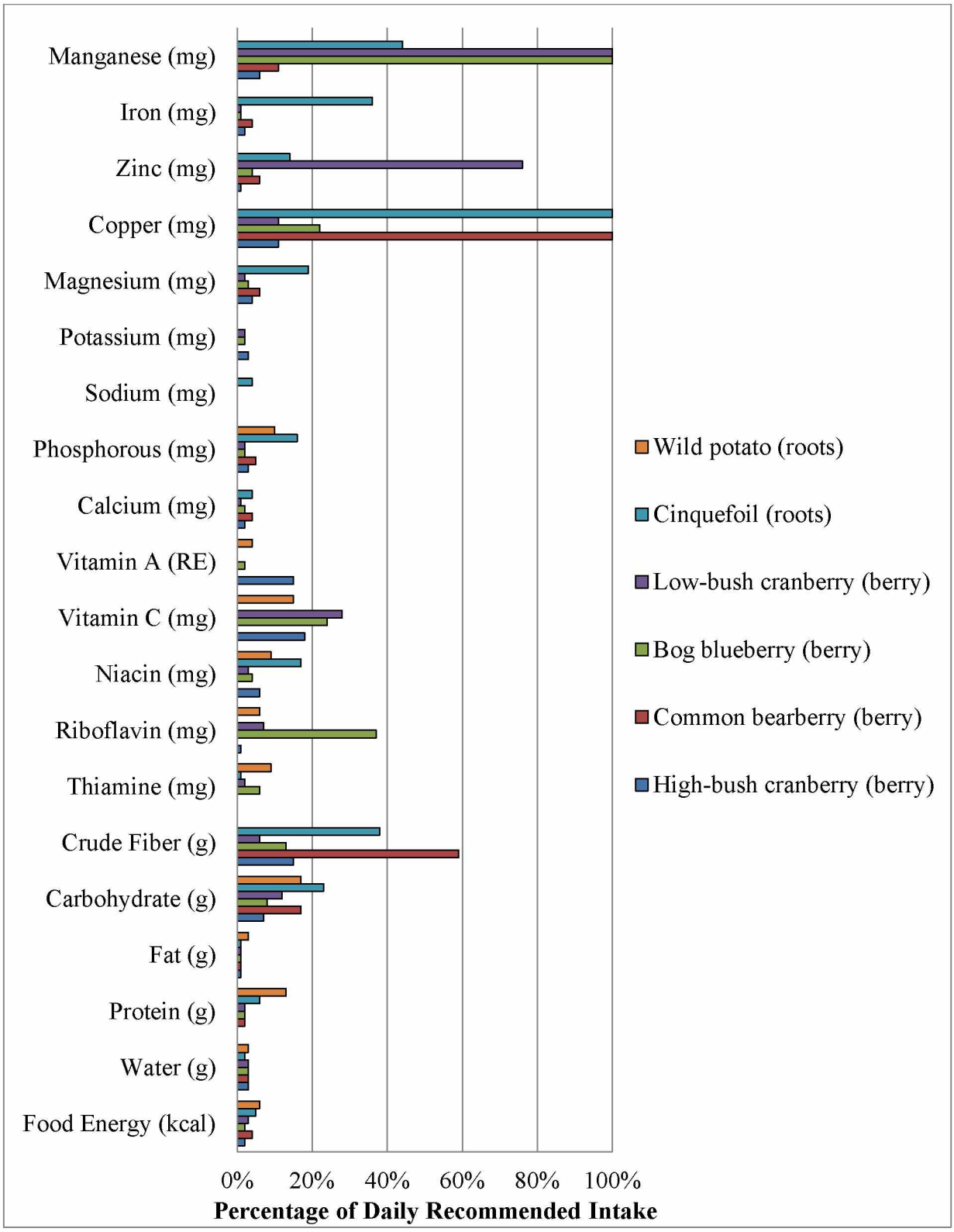

Figure 4.5 Fall Plant Nutrients (Adults 19-30 yr). This chart illustrates the percent contribution of select plant foods (100 g) to average recommended daily nutrient intakes for adults aged 19-30 years (NAS 2011; USDA 2015).

4.2.3 Winter (November through March)

In interior Alaska, extremely low temperatures and few hours of daylight characterize the winter season. During the Late Pleistocene and Early Holocene, winter residential base camps were probably located around productive riverine ecotones in lowland settings, where there was a greater likelihood of encountering bison and other large game (Glassburn 2015; Yesner 2001). The reliance on seasonally abundant resources between Middle to Late Holocene and recently recorded Athabascan populations suggests that there may also have been similarities in land use strategies (Potter 2008b).

The ethnographic record for interior Alaska suggests band dispersal into nuclear families during winter months, with subsistence revolving around stored goods and supplemented with fresh game whenever possible (Andrews 1975: Hosley 1981; Vitt 1971). Caribou hunting activities extended into November and winter camps often remained near the caribou fences, where they subsisted on dried and cached foods from the summer and fall harvesting activities (Andrews 1975; Hosley 1981; McKennan 1981; Vitt 1971). By late winter (March), stored foods ran low and starvation was not uncommon (Andrews 1975; Hosley 1981).

Building on previous reconstructions of subsistence and land use for interior Alaska, this model suggests that an assemblage produced in a winter occupation should reflect risk mitigating behavior. However, the scarcity of fresh plant foods throughout the winter months limits the chance for the deposition of an archaeobotanical assemblage during this season. Foraging efforts may have focused on hunting to supplement winter stores and provide fresh meat. Foragers likely broadened their diet breadth to include a wider variety of resources that, during resource-abundant summer months, were regarded as low-return or less desirable. Turner and Davis (1993) describe this behavior and the use of famine foods during times of resource stress recorded in the ethnographic record.

For all site types (base camps and task-specific camps) winter archaeobotanical assemblages should contain a low density and low diversity of any plant taxa at both the component- and feature-scale, reflecting the scarcity of fresh plant resources on the landscape. All features in a component should reflect equivalent use of stored winter foods and could include evidence of famine foods, resulting in high ubiquity values for taxa between features. In addition, the assemblage may contain evidence of taxa that over-winter on their plants, such as such as rosehips and crowberry. Due to the lack of fresh resource input, no task- specific activity

areas related to plant processing or storing are expected from a winter occupation. Instead, all features in a component should reflect equivalent use of any locally available plant resources. Table 4.7 highlights the trends expected for winter assemblage characteristics for different site types.

The potential for input of fresh plant resources is limited (Table 4.8), unless it includes low-return famine foods (such as lichens, particularly *Bryoria*, *Cetraria*, and *Cladina* spp.) or berries and buds that can stay on the plant year-round (such as rosehips, high-bush cranberry, silverberry, crowberry, and low-bush cranberry). The presence of these taxa might represent periods of starvation. Other species that may be present are those preserved during the fall season, discussed in the previous section, which would reflect use of winter stores.

Table 4.9 describes the expected winter faunal resources. During the Late Pleistocene and Early Holocene, bison and wapiti likely provided the main input of animal resources into the diet during the winter (Glassburn 2015), whether preserved or fresh. Some small mammals also could have contributed, such as hare, in addition to birds present year-round, such as ptarmigan and grouse (Potter et al. 2013). In Middle and Late Holocene components, there was likely more reliance on stored foods, such as dried salmon and caribou (Potter 2008b). The ethnographic record suggests that winter was a time of resource stress, and moose, caribou, small mammals, and birds were taken whenever encountered (Andrews 1975).

Table 4.7 Expected Winter Assemblage Characteristics. This table lists generalized expectations of winter assemblage characteristics discussed in the main text (modified from Bonzani 1997), assuming risk mitigating behavior and an expansion of diet breadth to include famine foods.

	Base Camp	**Task-Specific Camp**
Density	Low	Low
Diversity		
Feature	Low	Low
Component	Low	Low
Ubiquity	High	High
Content	Stored plant foods; famine foods; over-wintering plants	Stored plant foods; famine foods; over-wintering plants
Inferred Behavior	Risk avoidance; broadening diet breadth	Risk avoidance; broadening diet breadth

Table 4.8 Expected Winter Floral Resources. This table lists the floral resources expected in an archaeobotanical assemblage produced in the winter. Known presence refers to when the taxa appears in paleoenvironmental records (Bigelow 2013; Bigelow and Edwards 2001; Potter et al. 2011a; Zazula et al. 2006a). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation (Kari 1985; Kuhnlein and Turner 1991).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Betula glandulosa	Dwarf birch	LGM (genus)	
Betula neoalaskana	Paper birch	EH (genus)	
Alnus spp.	Alder	EH (genus)	
Viburnum edule	High-bush cranberry	No data	Yes
Juniperus communis	Mountain juniper	EH (genus)	
Elaeagnus commutata	Silverberry	LP/EH (genus)	
Empetrum nigrum	Crowberry	LP/EH (order)	Yes
Arctostaphylos uva-ursi	Common bearberry	LG (genus)	Yes
Ledum spp.	Labrador Tea	LGM (family)	
Vaccinium spp.	Low-bush cranberry	LP/EH (genus)	Yes
Hedysarum alpinum	Wild potato	LP/EH (genus)	Yes
Picea sp.	White and black spruce	EH (genus)	
Potentilla sp.	Cinquefoil	LGM (genus)	Yes
Rosa acicularis	Prickly rose	LGM (genus)	
Populus spp.	Balsam poplar and aspen	EH (genus)	
Salix spp.	Willow	LGM (genus)	

Table 4.9 Expected Winter Faunal Resources. This table lists the faunal resources expected in a winter occupation. Known presence refers to when the taxa appears in paleoenvironmental or archaeological records (Guthrie 2006; Potter 2008b; Potter et al. 2013). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, and LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation in the ethnographic or archaeological record (Andrews 1975; Potter et al. 2013; Shinkwin and Case 1984).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Bison sp.	Bison	LGM to LH	Yes
Cervus elaphus	Wapiti/elk	LGM-EH	Yes
Rangifer tarandus	Caribou	LGM	Yes
Alces alces	Moose	LP/EH	Yes
Ovis dalli	Dall sheep	LGM	Yes
Lepus americanus	Snowshoe hare	LGM	Yes
Spermophilus spp.	Ground squirrel	LMG	Yes
Lutra canadensis	River otter	LG	Yes
Marmota spp.	Marmot	LG	Yes
Castor canadensis	Beaver	LP/EH	Yes
Ursus sp.	Black and brown bear	LG	Yes
Birds	Grouse and ptarmigan	LG	Yes
Fur-bearers	Muskrat, marten, wolverine, lynx, red fox	LG	Yes
Anadromous fish	Salmon	LP/EH	Yes
Freshwater fish	Whitefish, grayling, burbot, pike	LG	Yes

Nutritional data derived from dried animal foods provides a generalized illustration of what contribution preserved foods could have in the diets of prehistoric foragers throughout the winter months (Figure 4.6). Dried fish and caribou offer a range of macro- and micro-nutrients, providing 100% of the daily recommended protein intake and smaller proportions of minerals such as copper and zinc. Although dried salmon and fish provide nearly 20% of the recommended daily fat allowance, the elevated protein content in fish, caribou, and other small mammal and bird resources likely exploited in times of resource stress (nutrients listed in previous seasons) suggests that fat intake was potentially reduced during the winter months. This suggests that a primary concern during winter months may have been protein poisoning. However, organs from fresh kills could also provide vitamins, minerals, and fat to even out the diet.

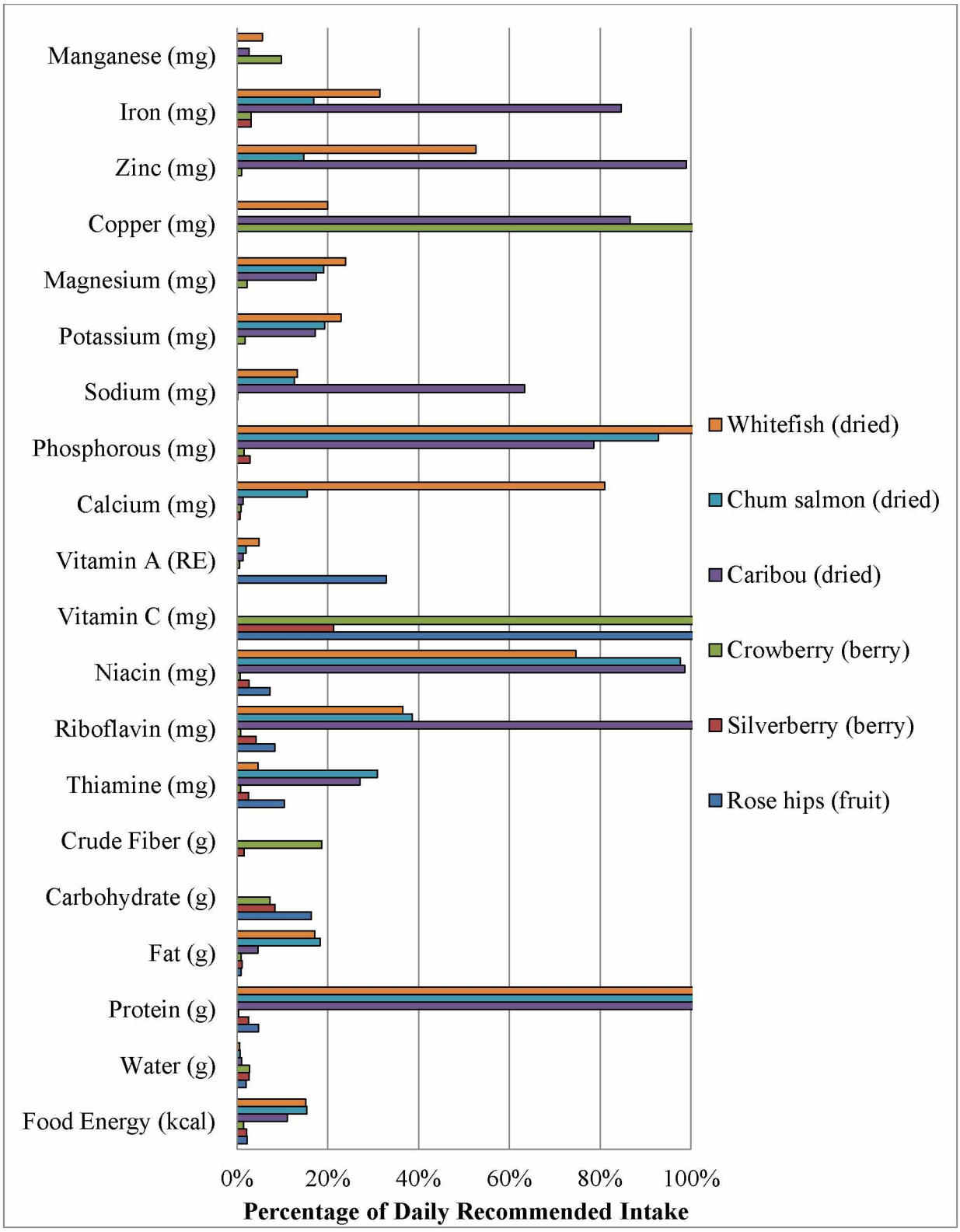

Figure 4.6 Winter Animal and Plant Nutrients (Adults 19-30 yr). This chart illustrates the percent contribution of select animal and plant foods (100 g) to average recommended daily nutrient intakes for adults aged 19-30 years (NAS 2011; USDA 2015).

Over-wintering plant resources, such as rosehips and crowberry, could provide more than half of the recommended daily Vitamin C intake for adults 19-30 years old. Famine foods (such as lichens and bark) may also have contributed to winter subsistence, though there are limited records on the nutrient values for these resources. From a nutritional standpoint, the input of any fresh meat to the diet during the winter should have similar nutritional values as in summer and fall months. However, animals hunted in later winter months may have had depleted fat reserves.

4.2.4 Spring (April through May)

During the Late Pleistocene and Early Holocene, foragers likely continued large mammal hunting in riverine ecotones and lowland settings, though by late spring mobility shifted to logistical hunting camps in upland locations (Glassburn 2015). Spring was likely the riskiest time of the year in terms of animal distribution and predictability. Although bison were likely available year-round, they were probably the most dispersed in spring (Glassburn 2015). Glassburn (2015) proposes greater spring mobility for Late Pleistocene populations and dispersal of nuclear families across the landscape to increase bison and large mammal encounter rates.

Similarly, spring may have been the riskiest time of the year for Middle and Late Holocene foragers as stored winter foods ran low and access to fresh resources was limited. Ethnographic records also note spring as a period of resources stress and starvation (Andrews 1975; Hosley 1981). However, migratory birds arrive in the Tanana River basin in May and were hunted around lakes and wetland locations (Andrews 1975; Olson 1968). Preparations for summer fishing activities occurred during the spring months (Andrews 1975; Hosley 1981; McKennan 1981). For groups that did not have access to large fish runs, there was more emphasis placed on hunting moose and caribou into early summer at the expense of fishing (Hosley 1981; Vitt 1971).

In this model, spring behavior may have emphasized minimizing the risk of potential periods of starvation. An archaeobotanical assemblage produced in this season would likely have a relatively low density and low diversity of plant resources when compared to other months (Table 4.10). This could reflect a period of resource scarcity after winter stores were exhausted. If a spring task-specific camp contains an archaeobotanical assemblage, then it may have a low density and diversity, but high ubiquity values for plant taxa, reflecting the use of any locally available plant resources.

Table 4.10 Expected Spring Assemblage Characteristics. This table lists generalized expectations of spring assemblage characteristics discussed in the main text (modified from Bonzani 1997), assuming risk mitigating behavior and an expansion of diet breadth to include famine foods.

	Base Camp	Task-Specific Camp
Density	Moderate	Low
Diversity		
Feature	Low	Low
Component	Moderate	Low
Ubiquity	Low	High
Content	Stored plant foods; famine foods; over-wintering plants; root foods and young leafy-greens	Stored plant foods; famine foods; over-wintering plants; root foods and young leafy-greens
Inferred Behavior	Risk avoidance; broadening diet breadth	Risk avoidance; broadening diet breadth

Task-specific areas related to the preparation of starchy root foods (available when the ground thaws) or famine foods that require a significant amount of processing for consumption, such as lichens (Turner and Davis 1993) may be present in spring base camp components. This should result in a low ubiquity value for those plant taxa across features in a component and low diversity values for individual features. At the component-scale, there may be a moderate diversity value associated with risk avoidance behavior and a broadening of diet breadth to include low-return foods often not considered during other seasons.

Table 4.11 is a list of plant taxa that are expected to appear in a spring assemblage. An early spring assemblage should appear similar to what is expected for late winter due to continued scarcity and unpredictability of resources on the landscape. Resources that may be present are famine foods, over-wintering plants, and plants used for functional purposes. The roots of wild potato (*Hedysarum alpinum*), mountain bistort (*Polygonum bistortum*), and spiny wood fern (*Dryopteris expansa*) are available for collection as soon as the ground thaws (Kari 1985; Kuhnlein and Turner 1991). After green-up, the leaves and shoots from leafy-green taxa such as horsetail (*Equisetum arvense*) and wild chive or onion (*Allium schoenoprasum*) are available for harvest.

Table 4.11 Expected Spring Floral Resources. This table lists the floral resources expected in an archaeobotanical assemblage produced in the spring. Known presence refers to when the taxa appears in paleoenvironmental records (Bigelow 2013; Bigelow and Edwards 2001; Potter et al. 2011a; Zazula et al. 2006a). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, and LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation (Kari 1985; Kuhnlein and Turner 1991).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Betula glandulosa	Dwarf birch	LGM (genus)	
Betula neoalaskana	Paper birch	EH (genus)	
Alnus spp.	Alder	EH (genus)	
Viburnum edule	High-bush cranberry	No data	Yes
Juniperus communis	Mountain juniper	EH (genus)	
Elaeagnus commutata	Silverberry	LP/EH (genus)	
Empetrum nigrum	Crowberry	LP/EH (order)	Yes
Equisetum arvense	Horsetail	LG (genus)	
Arctostaphylos uva-ursi	Common bearberry	LG (genus)	Yes
Ledum spp.	Labrador Tea	LGM (family)	
Vaccinium spp.	Blueberry/low-bush cranberru genus	LP/EH (genus)	Yes
Lupinus nootkatensis	Nootka lupine	No data	
Hedysarum alpinum	Wild potato	LP/EH (genus)	Yes
Allium schoenoprasum	Wild chive	No data	Yes
Epilobium spp.	Fireweed	LGM (genus)	
Picea spp.	White and black spruce	EH (genus)	
Polygonum bistorta	Mountain bistort	LGM (genus)	Yes
Athyrium filix-femina	Lady fern	No data	
Dryopteris expansa	Spiny wood fern	LG (genus)	
Potentilla sp.	Cinquefoil	LGM (genus)	Yes
Rosa acicularis	Prickly rose	LGM (genus)	
Populus spp.	Balsam poplar and aspen	EH (genus)	
Salix spp.	Willow	LGM (genus)	

Stored or fresh bison and wapiti could have provided meat resources to Late Pleistocene and Early Holocene winter forager diets (Table 4.12). In all time periods, animals were likely hunted whenever encountered, such as small mammals, such as hare, also could have contributed, in addition to birds present year-round, such as ptarmigan and grouse (Potter et al. 2013). Early spring would likely resemble a continuation of winter months in terms of resource availability and nutrient content. As the ground begins to thaw and green up occurs, access to fresh plant foods may have occurred and there was likely a greater contribution of migrating waterfowl to the diet.

Table 4.12 Expected Spring Faunal Resources. This table lists the faunal resources expected in a winter occupation. Known presence refers to when the taxa appears in paleoenvironmental or archaeological records (Guthrie 2006; Potter 2008b; Potter et al. 2013). LGM=Last Glacial Maximum, LG=Late Glacial, LP/EH=Late Pleistocene/Early Holocene transition, EH=Early Holocene, MH=Middle Holocene, and LH=Late Holocene. Storage and processing refers to taxa that are often mentioned in association with preservation in the ethnographic or archaeological record (Andrews 1975; Potter et al. 2013; Shinkwin and Case 1984).

Scientific Name	Common Name	Known Presence	Storage? Processing?
Bison sp.	Bison	LGM to LH	Yes
Cervus elaphus	Wapiti/elk	LGM to EH	Yes
Rangifer tarandus	Caribou	LGM	Yes
Alces alces	Moose	LP/EH	Yes
Lepus americanus	Snowshoe hare	LGM	Yes
Spermophilus spp.	Ground squirrel	LMG	Yes
Lutra canadensis	River otter	LG	Yes
Marmota spp.	Marmot	LG	Yes
Castor canadensis	Beaver	LP/EH	Yes
Ursus sp.	Black and brown bear	LG	Yes
Birds	Grouse, ptarmigan, waterfowl	LG	Yes
Fur-bearers	Muskrat, marten, wolverine, lynx, red fox	LG	Yes
Anadromous fish	Salmon	LP/EH	Yes
Freshwater fish	Whitefish, grayling, burbot, pike	LG	Yes

Wild chives or onions and horsetail provide around 50% of the recommended daily Vitamin C intake (Figure 4.7). The roots from mountain bistort and spiny wood fern contain minerals such as manganese, iron, and magnesium. Large mammals were likely actively sought after, though their fat contribution to the diet was likely lessened compared to summer and fall months. Similar to late winter, protein poisoning was probably the main concern for early spring months. However, fresh kills could provide necessary micro- and macro-nutrients in organs, in addition to protein and fat.

4.2.5 Year-Round and Functional Plant Use

While the use of many plant species varies on a seasonal basis, some taxa are available for use year-round. These species likely influenced foraging activities, but they are not useful as indicators of seasonal change in foraging behavior. These include woody taxa, such as trees and shrubs, which are frequently used for multiple purposes such as fuel or for the construction of structures and implements. Unless direct evidence is available, it may be difficult to distinguish the specific use of the plant resource from the archaeobotanical record alone.

For example, the ethnographic record suggests the collection of young willow buds and leaves in the spring for food or medicine and the cambium from cottonwood and aspen for consumption (Kari 1985; Kuhnlein and Turner 1991). However, the ethnographic record also notes the collection and use of these taxa year-round for fuel and other purposes (Kari 1985; Kuhnlein and Turner 1991). Juniper (*Juniperus communis*) is potentially important as food or medicine but is also present year-round (Kari 1985). These examples illustrate the reasons why certain plant taxa may not be good indicators of seasonal variation in foraging behavior. Figure 4.8 provides an overall summary of expectations for year-round and seasonal plant resource use.

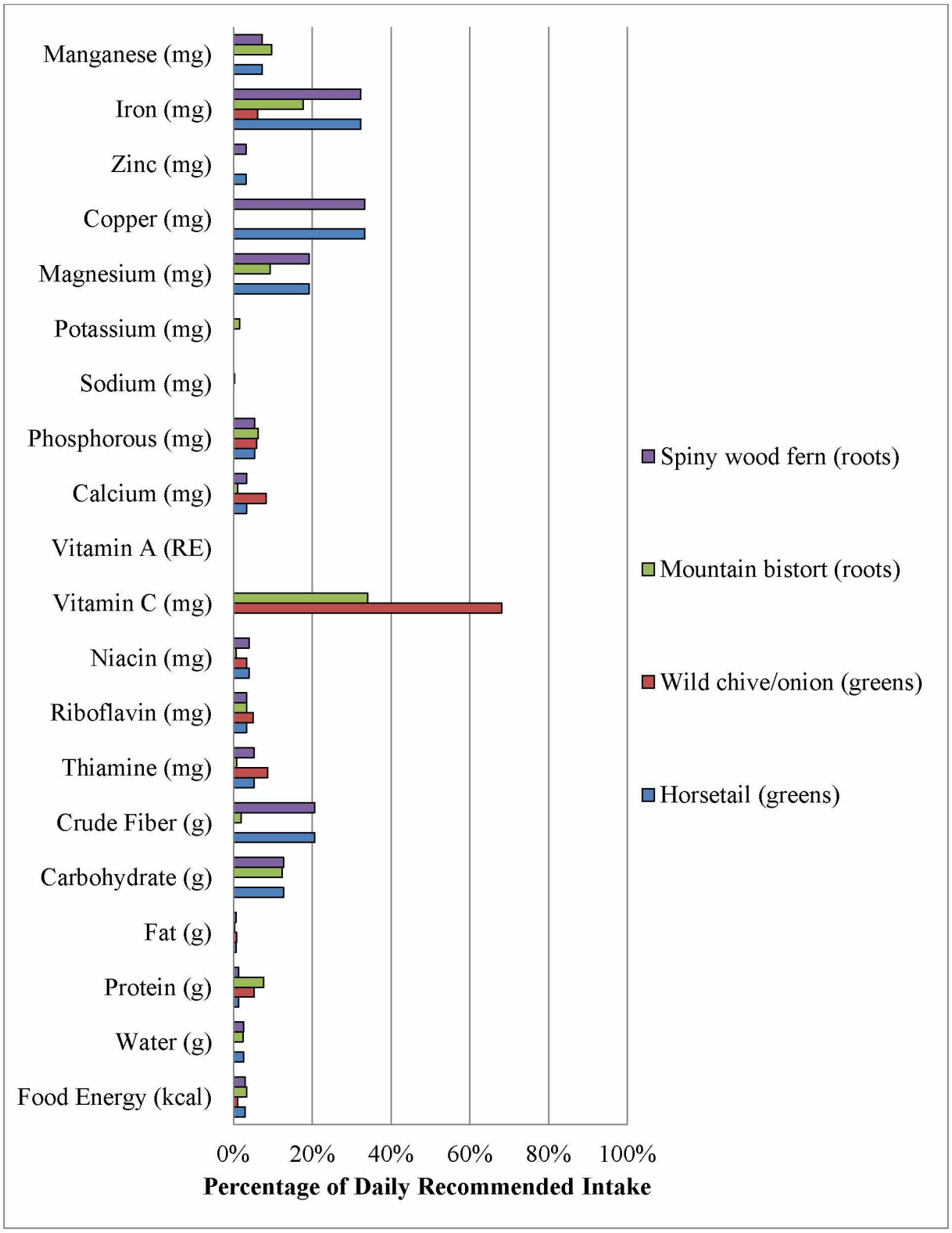

Figure 4.7 Spring Plant Nutrients (Adults 19-30 yr). This chart illustrates the percent contribution of select plant foods (100 g) to average recommended daily nutrient intakes for adults aged 19-30 years (NAS 2011; USDA 2015).

Figure 4.8 Generalized Seasonal Model. This figure illustrates the different types of plant taxa described in the main text and the seasons in which they are expected to appear in an archaeobotanical assemblage. Darker shades represent greater confidence in exploitation during the respective season. Translucent lines indicate that the taxa may be present on the landscape in the respective season, though the model does not expect their exploitation at that time.

Chapter 5

Results from the Upward Sun River Site

In the first section of this chapter, I discuss the environmental and stratigraphic context of Upward Sun River and provide radiocarbon dates on culturally and economically important plant remains from the site (Potter et al. 2011a, 2014). I also consider problems of equifinality at Upward Sun River and define density and diversity classifications for the site. The following sections present the content, diversity, density, and ubiquity of Components 1 and 3 features. The last section compares archaeobotanical data from the Gerstle River site to the Upward Sun River data. Deviations from seasonal expectations point to factors other than optimal foraging or risk minimizing behavior that may have influenced plant use, such as cultural preference, depositional and taphonomic biases, and fluctuations in resource availability.

5.1 The Upward Sun River Site

Upward Sun River sits on a loess-mantled sand dune south of the Tanana River. Site stratigraphy reflects rapid aeolian deposition, short periods of soil development with stabilization of the landscape, and minimal disturbance of archaeological components (Potter et al. 2011a; Reuther 2013). Research at the site explores subsistence, technology, economy, and mortuary behavior with analysis of floral, faunal, lithic, and human remains (Halffman et al. 2015; Potter et al. 2007a, 2008, 2011a, 2014; Tackney et al. 2015). Radiocarbon dates from hearth feature charcoal (identified by Claire Alix, UAF, and Owen Davis, University of Arizona) establish a chronology for human occupation at the site (Potter et al. 2011a, 2014). Gelvin-Reymiller identified macroremains in a Component 1 feature (Potter et al. 2007a, 2008) and conducted flotation on the Component 3 cremation feature, which I include in the presentation of results.

Potter et al. (2011a) and Reuther (2013) detail the site stratigraphy that I outline here (Figure 5.1). Component 1 (13,300-13,120 cal yr BP) lies in the Unit 2 lower loess deposit above Unit 1b dune sands and corresponds to the Bølling-Allerød interstadial. Unit 3 sand lenses overlie Unit 2 silts. Component 2 (11,900-11,620 cal yr BP) corresponds with the late Younger Dryas and a series of buried soils (P1b, Pedocomplex 1) in the Unit 4 upper silt deposit. Component 3 (11,620-11,280 cal yr BP) is contemporaneous with the transition from the Younger Dryas to the Holocene Thermal Maximum and the component may be associated with a weakly-expressed paleosol in Pedocomplex 2 (P2). Component 4 (10,170-9790 cal yr BP)

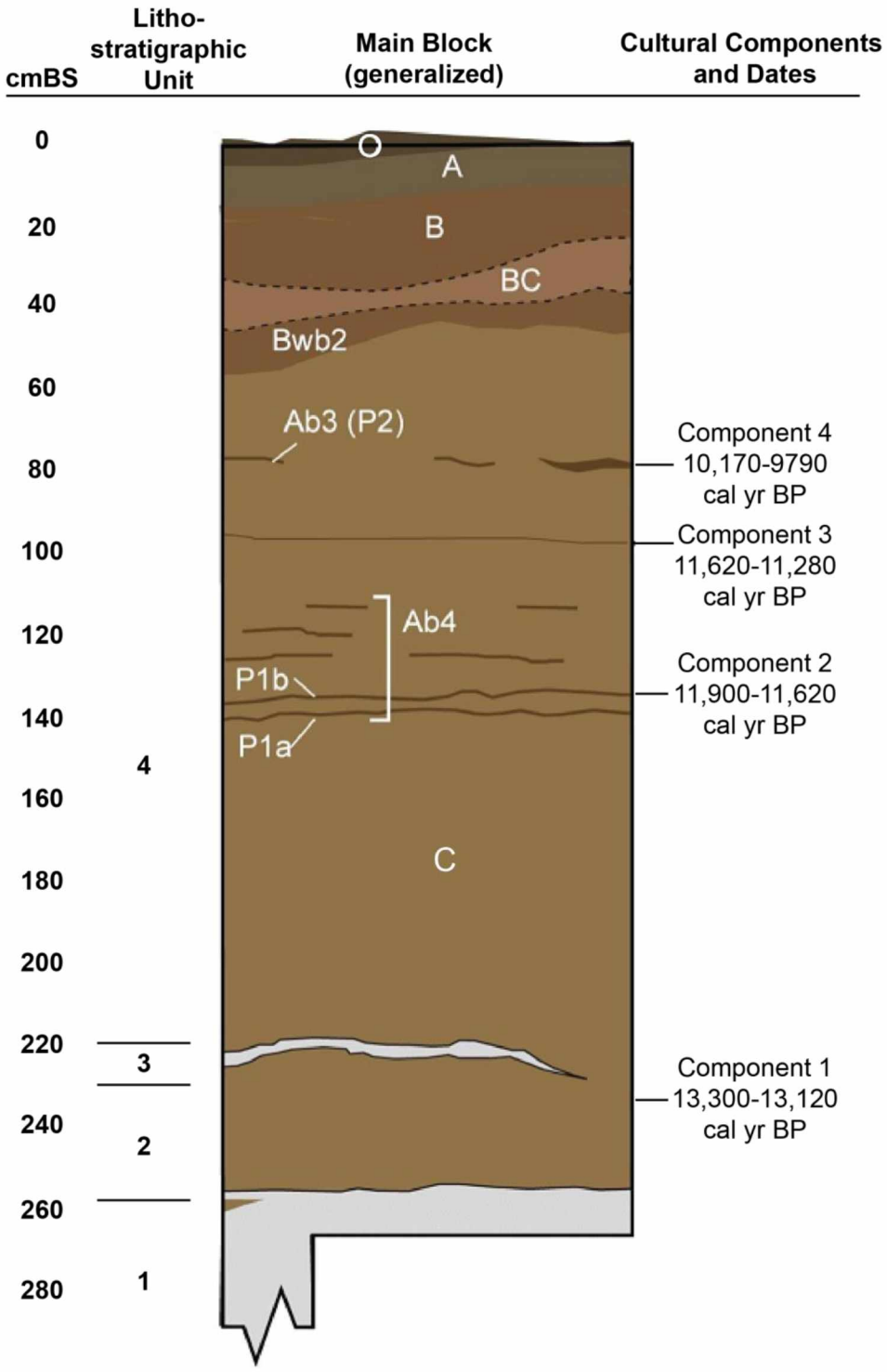

Figure 5.1 Generalized Stratigraphic Profile. This figure illustrates soil horizons and lithostratigraphic units for Upward Sun River that Potter et al. (2011a) and Reuther (2013) describe in greater detail. Components and their respective calibrated radiocarbon dates are also provided. Figure courtesy of Ben A. Potter.

corresponds to the latter half of the Holocene Thermal Maximum and the component is associated with a buried soil (Ab3) in Pedocomplex 2. Pedocomplex 3 contains Middle to Late Holocene soils, consisting of two Bwb horizons that coincide with the spread of forest around 9,000 cal yr BP. OA, B, and BC horizons make up the surficial forest soils.

Previous research at the Upward Sun River site focused on Component 1 (13,300-13,120 cal yr BP) and Component 3 (11,610-11,280 cal yr BP) due to the density and preservation of features and artifacts (Potter et al. 2011a, 2014). This thesis likewise focuses on Components 1 and 3 to strengthen inferences of plant resource use with reconstructions of foraging behavior developed from lithic and faunal datasets (Potter et al. 2011a, 2014). Overall, Components 1 and 3 at Upward Sun River indicate broad-spectrum foraging and exploitation of local resources such as fish, waterfowl, small game, and some large ungulate species (Potter et al. 2011a; 2014). The site may have served as a base camp, with close proximity to the Tanana River and access to important resources (Potter et al. 2011a). The descriptions of the hearth features that follow were derived from Potter et al. (2007a, 2008, 2011a) or Potter (2015, personal communication).

5.1.1 Charcoal and Plant Macroremain Radiocarbon Assays

Radiocarbon dating of charcoal and plant macroremains can identify the presence of culturally, economically, and ecologically significant plant taxa in interior Alaska. Original publications present the full results of radiocarbon assays on identified charcoal from Upward Sun River (Potter et al. 2011a; Potter et al. 2014). This research did not include systematic sampling and identification of hearth charcoal due to time constraints. However, I consider previously identified charcoal in terms of taxa presence or absence (Table 5.1).

In addition to the arrival of tree taxa on the landscape, the presence of edible plants likely influenced subsistence and settlement in interior Alaska. Carbonized nagoonberry, blueberry or low-bush cranberry species, and common bearberry seeds were sent to Beta Analytic, Inc. for radiocarbon dating (Table 5.2). The dates from Features 2011-6A (Component 3) and 2014-5 (Component 1) are consistent with previous dates on charcoal. The date on the macroremains from Feature 2010-5 (Component 3) is approximately 500 cal yr BP younger than previous dates established on charcoal. However, the matrix sample that contained the nagoonberry seeds was collected from the surface of the cremation pit (Feature 2010-5) and it is possible that the macroremains were incorporated into the fill during post-depositional disturbance.

Table 5.1 Charcoal Identifications. The presence (P) and absence (A) of tree and shrub charcoal in the four components at the Upward Sun River Site (Potter et al. 2011a, 2014). The charcoal specimens were identified by Claire Alix (UAF) and Owen Davis (UA). "Cf." refers to potential identifications.

Taxon	Component 1	Component 2	Component 3	Component 4
Amelanchier sp. Serviceberry sp.	A	P	A	A
Betula sp. Birch sp.	A	A	P	A
Populus/Salix sp. Aspen, balsam poplar, or willow sp.	A	A	P	A
Populus balsamifera Balsam poplar	A	A	P	A
cf. *Populus tremuloides* cf. Aspen	A	A	A	P
Salix sp. Willow sp.	P	P	P	P

Table 5.2 Plant Macrofossil Radiocarbon Dates. All radiocarbon dates were calibrated with the IntCal 13 database. Contextual information for each feature is provided in the main text. "Cf." refers to potential identifications.

Lab #	Provenience	Depth (cm BS)	Taxon ID	Conventional Radiocarbon Date	δ^{13} (‰)	Cal yr BP (2σ)
Beta-423592	F2010-5, Component 3	~80	*Rubus* cf. *arcticus* cf. Nagoonberry	9,650±30 BP	-28.8	10,950-10,870
Beta-423593	F2011-6A, Component 3	~80-90	cf. *Vaccinium* sp. cf. Blueberry/low-bush cranberry sp.	9,860±40 BP	NA	11,315-11,210
Beta-423594	F2014-5, Component 1	~260-270	*Arctostaphylos uva-ursi* Common bearberry	11,330±40 BP	-27.9	13,270-13,095

The radiocarbon dates derived from these species firmly establishes their presence on the landscape at the time the Upward Sun River site was occupied. The general trends in vegetation change outlined in Chapter 3 correspond with the presence of tree and shrub taxa at Upward Sun River. Tree taxa are absent from Components 1 and 2 but are present in Components 3 and 4. This is consistent with pollen records for interior Alaska, which suggest that tree taxa do not become prevalent on the landscape until the Early Holocene, initially with balsam poplar or aspen and subsequently with spruce (Anderson et al. 2004). The soil sequence at the site suggests that vegetation was more extensive for a longer period during Component 4 (Pedocomplex 2) than during Component 3, when soil development was minimal (Reuther 2013).

5.1.2 Equifinality and Macroremain Deposition

For comparison with the model expectations, I assume that the trends observed in archaeobotanical assemblages directly relate to prehistoric foraging behavior. However, other processes can produce similar trends in content, density, diversity, and ubiquity. Sampling strategies can influence macrobotanical assemblages and careless processing can lead to contamination with unrelated plant materials (Dincauze 2000; Keepax 1977). In this section, I describe potential problems associated with equifinality and deposition that could influence the archaeobotanical record at Upward Sun River and comparisons to Gerstle River macroremains.

Uncarbonized plant remains were recovered from several features (see Appendix D), though this research assumes that these remains are modern contaminants and excludes them in the discussion of results. Comparison between the Upward Sun River features and the control samples for the site supports the interpretation that carbonized remains are the result of human deposition in hearth feature contexts (see Appendix C). Overall, few macrobotanical remains were recovered from the control samples.

The exposure of macrobotanical remains at the surface of an archaeological site increases the chance of destruction (Ford 1979; Gallagher 2014). During the last glacial period, increased sedimentation rates may have led to rapid burial of archaeological sites in interior Alaska (Begét 1996, 2001; Mahowald et al. 1999). In sites that experienced rapid sediment deposition following site occupation, I expect better preservation of organic remains. In addition to aiding macrobotanical preservation, rapid sediment deposition allows for clearer distinction between archaeological, paleoenvironmental, and geologic depositional events.

Acidic soils can inhibit microbial decomposition and increase the chance of preservation (Gallagher 2014). Experimental research suggests that carbonized remains exposed to alkaline conditions will break down faster than those in neutral environments (Braadbaart et al. 2009; Gasser and Adams 1981). The opposite is true in the faunal record, with bone deteriorating rapidly in acidic environments. As soils became more acidic with the development of the boreal forest in interior Alaska during the Middle to Late Holocene (Thorson 1990), the potential for preservation of plant remains may have increased. However, Middle to Late Holocene soils contain natural staining and charcoal associated with forest fires, which is difficult to distinguish from anthropogenic deposits. This complicates component delineation, feature identification, and sampling strategies for radiocarbon dating.

The environmental context of the site determines the suitability of laboratory procedures for separating plant remains from feature matrix. In arid environments, water can weaken desiccated plant remains and dry screening with a fine mesh-size may be necessary (Pearsall 2000; White and Shelton 2014). On the other hand, wet-sieving is practiced when plant remains are water-logged or weighted down by clay because methods such as flotation rely on plant buoyancy (White and Shelton 2014). For the Upward Sun River site, there may be issues of comparability between the remains floated by Gelvin-Reymiller (Potter et al. 2007a, 2008) and those wet-sieved for this research. However, the recovery of fragile carbonized remains, such as the blueberry or low-bush cranberry species, from wet-sieved materials suggests that the process was gentle enough to recover a variety of remains preserved at the site.

Table 5.3 presents the total raw and standardized macroremain counts for the entire Upward Sun River archaeobotanical assemblage. The inclusion of bud scales from tree and shrub taxa is expected. While these species do not contribute a large percentage to the overall standardized macroremain count, they may have served as a fuel source for site inhabitants. Although systematic charcoal sampling was outside the scope of this research project, tree and shrub taxa such as willow, birch, aspen, and balsam poplar were identified in charcoal samples sent for radiocarbon dating. Fragile blueberry or low-bush cranberry seeds constitute a higher percentage (~11%) of the overall assemblage than robust seeds, such as nagoonberry (less than 1%). The fragility of the blueberry or low-bush cranberry seeds suggests that they were recovered from primary context because significant post-depositional disturbance would have damaged the remains.

Table 5.3 Total Upward Sun River Archaeobotanical Assemblage Content. This table lists the total raw and standardized counts of each taxon in Components 1 and 3 from the Upward Sun River Site and their respective percentage contributions to the standardized total assemblage. "Cf." refers to potential identifications.

Taxon	Raw Sum	Standardized Sum	% Standardized Sum
Arctostaphylos uva-ursi Common bearberry	205	137.66	70.63
cf. *Arctostaphylos uva-ursi* cf. Common bearberry	3	0.33	0.17
cf. *Arctos alpina* or *A. rubra* cf. Alpine or red-fruit bearberry	3	1.98	1.02
Carex sp. Sedge sp.	10	1.97	1.01
cf. *Carex* sp. cf. Sedge sp.	8	3.19	1.64
cf. *Picea* sp. cf. Spruce sp.	1	0.42	0.21
Potentilla sp. Cinquefoil sp.	1	0.11	0.06
cf. *Potentilla* sp. cf. Cinquefoil sp.	1	0.66	0.34
Rubus cf. *arcticus* Raspberry genus species, cf. Nagoonberry	5	0.56	0.29
Ericaceae sp. Heather family sp.	1	0.11	0.06
Rosaceae sp. Rose family sp.	4	0.45	0.23
cf. *Caltha* sp. cf. Marsh marigold sp.	1	0.11	0.06
cf. *Vaccinium* sp. cf. Blueberry/low-bush cranberry sp.	41	21.03	10.79
cf. *Thalictrum* sp. cf. Meadow rue sp.	1	0.55	0.28
Type 1 Seeds	1	0.42	0.21
Unidentifiable seeds	25	9.25	4.74
Unidentified seeds	2	0.83	0.43
cf. *Salix* sp. bud scale cf. Willow sp. bud scale	6	3.73	1.91
cf. *Populus* sp. bud scale cf. Aspen or balsam poplar bud scale	2	1.10	0.57
Unidentified buds/bud scales	28	10.44	5.36
Density (Total N)	349	194.90	100
Total Sed. Volume	38.09 L		

The abundance of the common bearberry (~71% of the assemblage) is expected because the seeds are dense and likely withstand post-depositional processes better than more fragile remains. In addition, common bearberries are often processed or cooked before consumption (Holloway and Alexander 1990; Jones 2010; Kari 1985), which increases their chance of deposition and preservation in hearth features. The taxon's abundance could also represent removal of the large seeds before consumption and disposal in hearth features.

Although archaeobotanists attempt to limit sampling biases by processing the same amount of matrix from each context, this is not always possible when working within the limits of a finite feature, such as a hearth (Gallagher 2014). In addition, temporal and monetary constraints may limit how much matrix can be processed and analyzed (Dincauze 2000; Ford 1979; Pearsall 2000; Lepofsky et al. 2001). To examine if there is a relationship between the total volume of sediment processed and the diversity of macrobotanical remains recovered from each feature, these data are plotted against one another (Figure 5.2 and 5.3).

Figure 5.2 suggests that there may be a positive relationship between the amount of feature matrix processed and the diversity values for the Upward Sun River features. In general, the more feature matrix that is processed, the greater the diversity of the feature. For example, Feature 2010-5 has the most matrix volume processed (16.25 L) and also has the highest diversity value of all of the features at the site (H'=2.151). However, the opposite is true with the Gerstle River features, as the two features with the most sediment processed have the lowest diversity values. Although standardization can limit density-related biases in an assemblage, it does not always account for the greater range of taxa identified in larger samples (Popper 1988).

The cremation hearth (Feature 2010-5) has the greatest diversity of the Upward Sun River features, although it is difficult to determine whether this is due to the context of the remains, or due to the large amount of matrix processed. The feature's floral and faunal remains likely result from backfill of the cremation with the contents from an older hearth (Potter et al. 2011a). This interpretation is supported by the lack of macroremains in the double-infant burial (Feature 2011-13), although the difference may be the result of taphonomy and reduced chances of preservation for uncarbonized remains. Figure 5.3 suggests that there is a strong linear relationship between the amount of sediment processed and the diversity values for Upward Sun River features when the cremation pit (Feature 2010-5) is excluded as an outlier, while the opposite trend is present with the Gerstle River features.

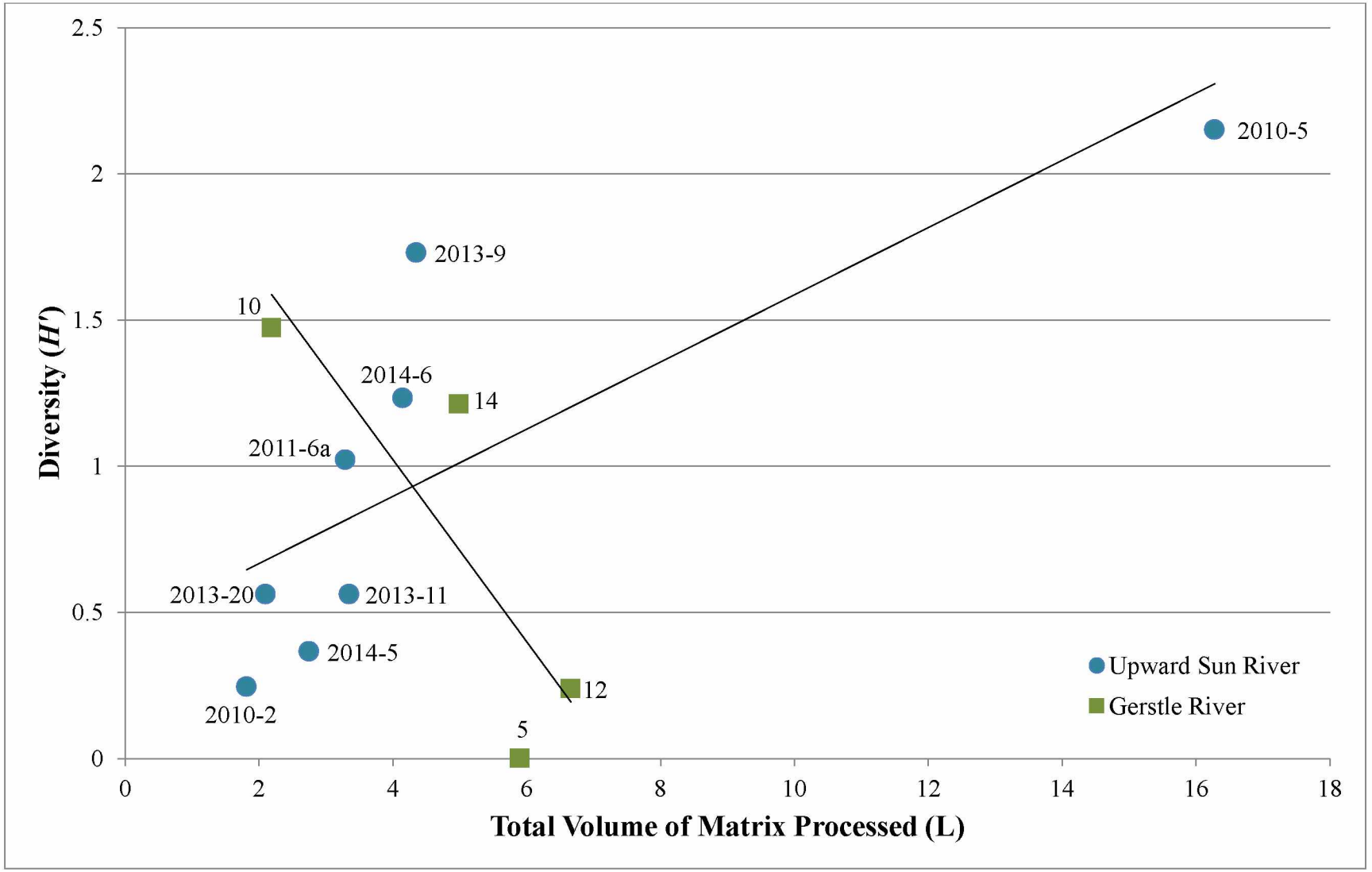

Figure 5.2 Total Volume of Matrix Processed vs. Diversity. This graph plots the diversity (*H'*) of each feature against the total volume of feature matrix processed (L) for Upward Sun River and the comparative features from Gerstle River.

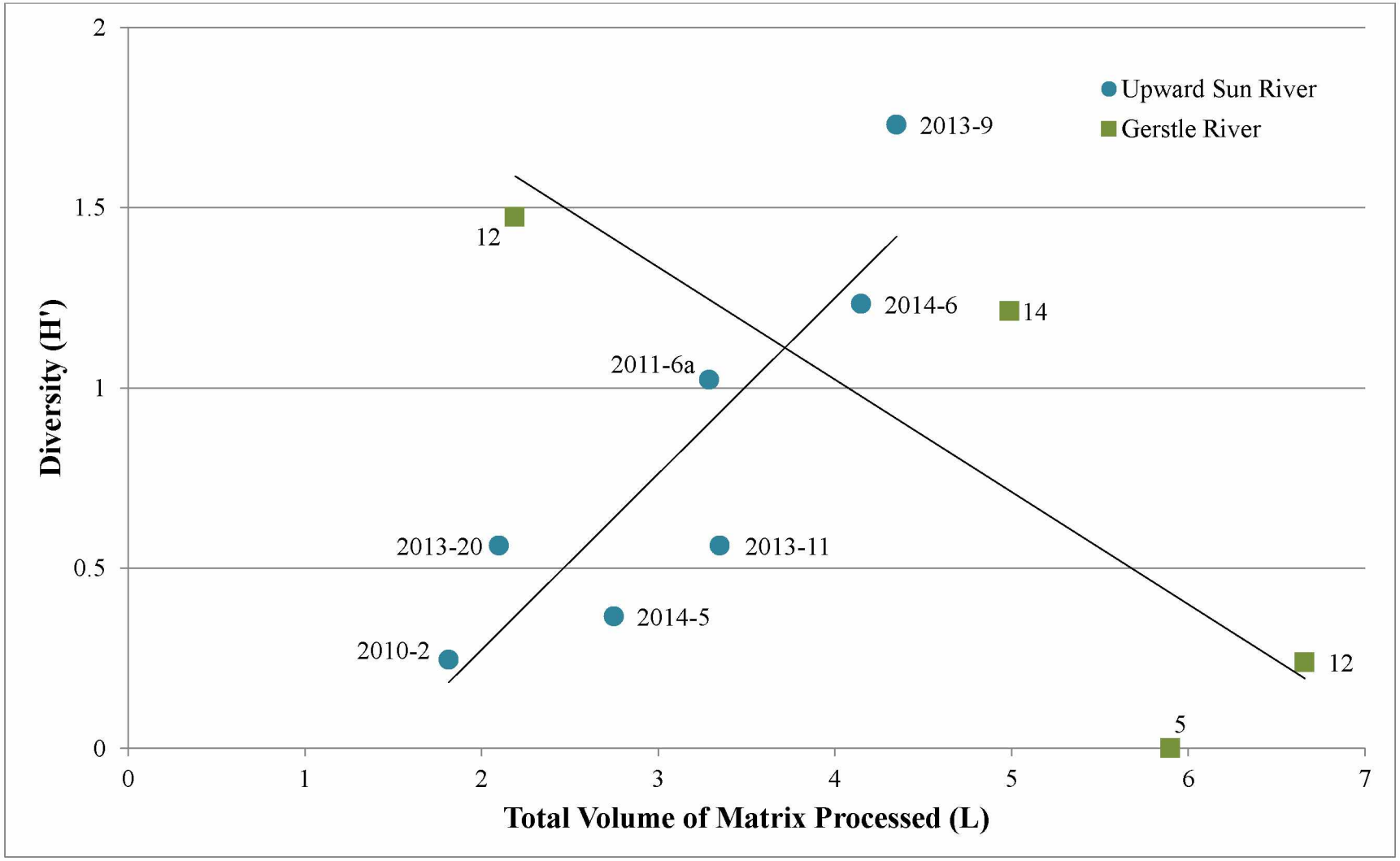

Figure 5.3 Total Volume of Matrix Processed vs. Diversity Without Outlier. This graph plots the diversity (*H'*) of each feature against the total volume of feature matrix processed (L) for Upward Sun River and Gerstle River, without the outlier cremation Feature 2010-5.

5.1.3 Density and Diversity Classifications

Classification of archaeobotanical assemblage characteristics as low, medium, or high is site-specific. Table 5.4 summarizes the value range for classifications at Upward Sun River. With the Shannon-Weaver Index, higher numbers represent greater diversity and a value of 0 represents an assemblage with one species. Feature 2010-5 has the highest diversity value (*H'*=2.151) and defines the upper limit (the most diverse) for classifications of diversity for the site. For density, Feature 2010-2 defines the upper limit (N=30) for the Upward Sun River assemblage. Although Feature 2014-5 has the densest assemblage (N=174 raw and 114.84 standardized), it is an outlier and use of this value as the upper limit for density would skew all other features to have low density values. The following sections compare Components 1 and 3 archaeobotanical assemblages in light of model expectations developed in Chapter 4.

Table 5.4 Upward Sun River Diversity and Density Classifications. This table presents the range in values for low, medium, and high diversity and density (standardized N) specific to the Upward Sun River site.

Classification	Diversity (*H'*)	Density (N)
High	1.567 to 2.151	22.5 to 30
Medium to high	0.984 to 1.567	15 to 22.5
Low to medium	0.492 to 0.984	7.5 to 15
Low	0 to 0.492	0 to 7.5
No diversity/density	0	0

5.2 Component 1 (13,300-13,120 cal yr BP)

After the development of the dune feature underlying Upward Sun River, factors such as change in sediment supply, aeolian activity, and vegetation cover influenced landform stability and loess deposition (Potter et al. 2011a; Reuther 2013). The site was occupied during Component 1 (Figure 5.4), which corresponds to the Bølling-Allerød interstadial (16,000 to 12,900 cal yr BP) and a shift in dominance from herbaceous to shrub-tundra vegetation communities (Björck 2007; Bigelow and Edwards 2001; Viau et al. 2008). This component contained two hearth features (Features 2010-2 and 2014-5) and associated waterfowl, small mammal, and artiodactyl remains (Potter et al. 2008). Features 2010-2 and 2014-5 from Component 1 also contained macrobotanical remains (Table 5.5 and Figure 5.5).

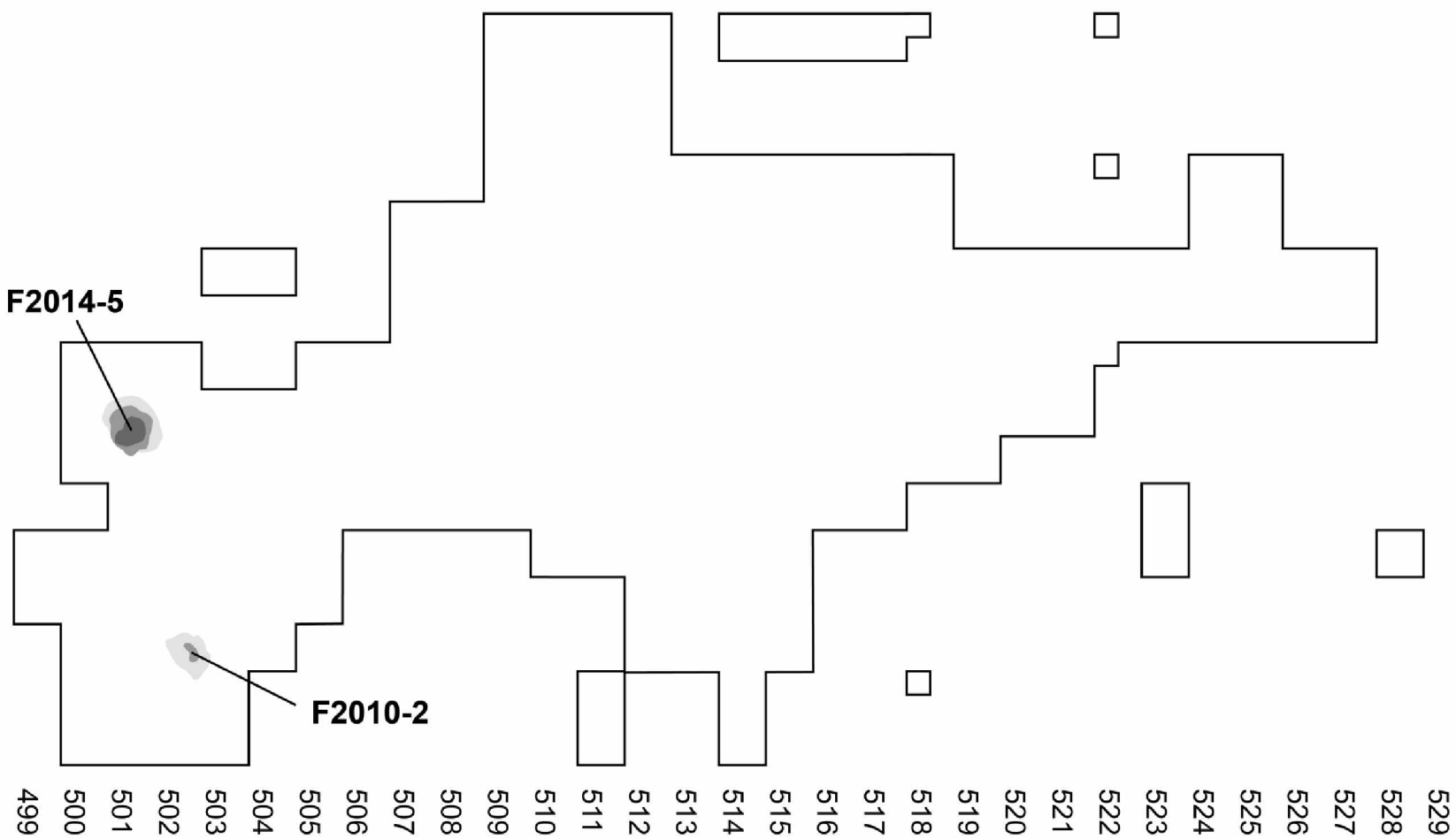

Figure 5.4 Component 1 Features. This plan view map shows the location of Features 2014-5 and 2010-2 in Component 1 at the Upward Sun River site. The numbers lining the map refer to the arbitrary meter grid system established at the site to record provenience.

Potter et al. (2008) define Component 1 as an early fall occupation due to the abundance of migratory waterfowl and common bearberry seeds found in association with hearth Feature 2010-2, which was processed by Carol Gelvin-Reymiller. Based on this assessment, fall season (September through October) expectations should apply. Restated briefly here, site occupants may have focused on hunting large mammals in logistically organized camps during the fall, with base camps situated in productive ecotones to access a variety of resources (Glassburn 2015; Yesner 2001). Foraging activities may have focused on mitigating the risk of starvation in late winter and spring. An archaeobotanical assemblage for fall base camps should have a medium density of macrobotanical remains, low diversity at the feature-scale, and medium diversity at the component-scale. Fall components should contain evidence of task-specific areas related to preservation and storage, resulting in a low ubiquity value for plant taxa and low diversity values for individual features. Predictable and storable resources should dominate the archaeobotanical assemblage. Special purpose camps should have low density and diversity, while ubiquity should be high, reflecting immediate consumption events.

Table 5.5 Component 1 Macroremains. This table presents the raw (R) and standardized (S) counts, density, and diversity for Component 1 features. The counts from all features are standardized based on the feature with the smallest amount of sediment processed at the site (Component 1, Feature 2010-2 at 1.815 L). This allows for comparison between features and components. Carol Gelvin-Reymiller processed and identified the remains from Feature 2010-2 (Potter et al. 2007a, 2008). "Cf." refers to potential identifications.

Taxon	Component 1 Features			
	2010-2		2014-5	
	R	S	R	S
Arctostaphylos uva-ursi (common bearberry)	28	28	162	106.92
cf. *Arctous alpina/rubra* (cf. alpine/red fruit bearberry)	0	0	3	1.98
Carex sp. (sedge)	0	0	1	0.66
cf. *Carex* sp. (cf. sedge)	0	0	3	1.98
cf. *Potentilla* sp. (cf. cinquefoil)	0	0	1	0.66
Unidentifiable seeds	0	0	3	1.98
cf. *Salix* sp. bud scale (cf. willow sp. bud scale)	0	0	1	0.66
Unidentified bud scales	2	2	0	0
Density (N)	30	30	174	114.84
Total Sed. Volume (L)	1.815		2.75	
Diversity (*H'*)	0.245		0.366	

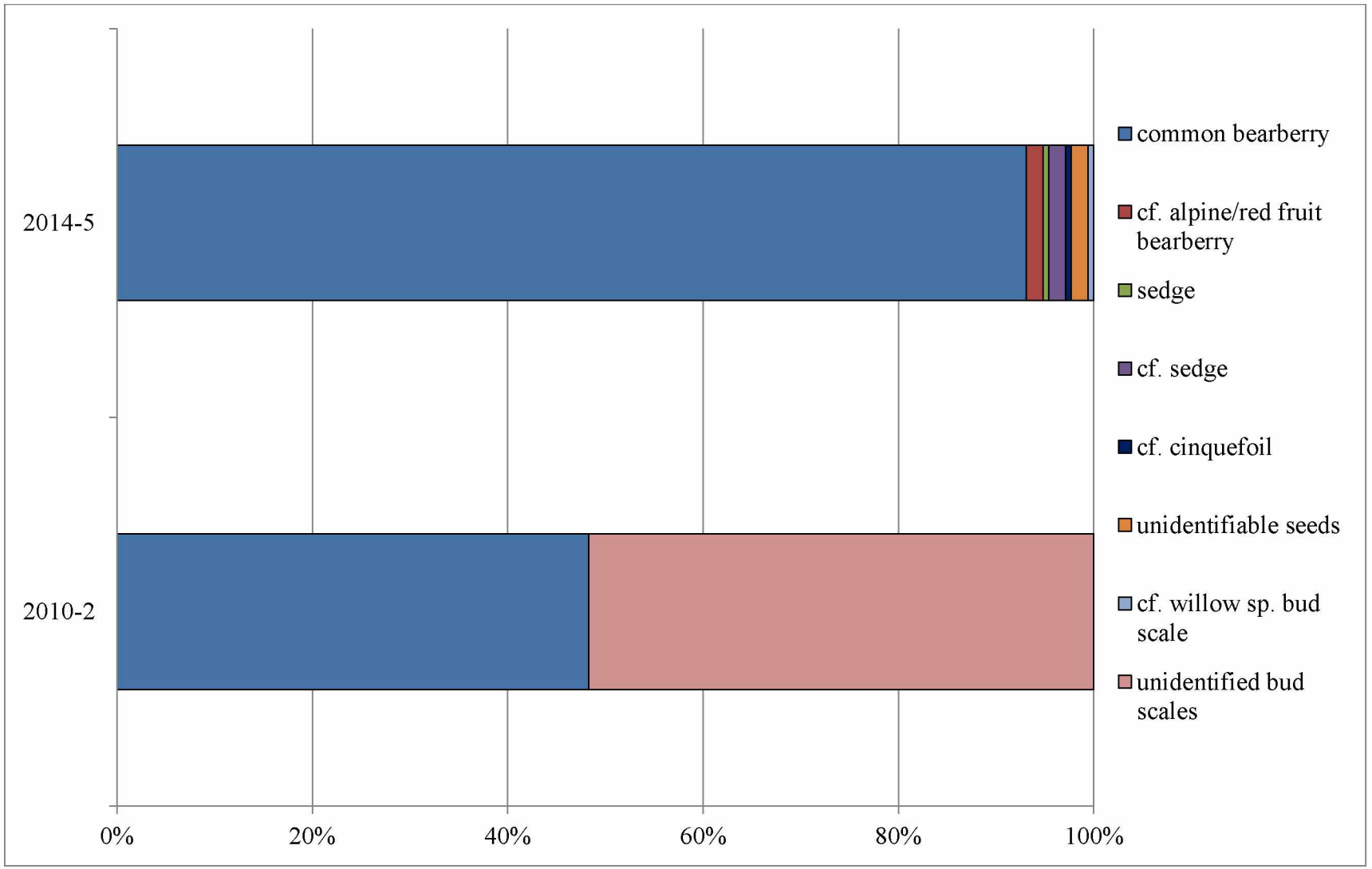

Figure 5.5 Percent Presence of Component 1 Macroremains. This figure illustrates the percent presence of plant taxa from the Upward Sun River site Component 1 archaeobotanical assemblage. Carol Gelvin-Reymiller processed and analyzed the remains from Feature 2010-2 (Potter et al. 2008). Both features are hearths. "Cf." refers to potential identifications.

5.2.1 Feature 2010-2 (13,400-13,100 cal yr BP)

Feature 2010-2 is defined as an unlined hearth produced during an open-air, short-term occupation with associated lithic and faunal remains (Potter et al. 2007a). Some faunal remains are calcined, though the feature was not oxidized. The main feature consisted of gray-stained matrix approximately 50x25 cm in dimension with a dense concentration of charcoal. A greater area approximately 100x75 cm contained scattered charcoal (Potter et al. 2007a). Gelvin-Reymiller processed and analyzed the feature for macrobotanical and microfaunal remains (Potter et al. 2007a, 2008). Based on the abundance of migratory waterfowl, which are most vulnerable during the early autumn molt, and the presence of common bearberry, which ripens in autumn, Potter et al. (2008) suggest early fall use of Feature 2010-2.

This feature contained only one identified taxon, common bearberry, in addition to two unidentified bud scales (Table 5.5). In general, the assemblage from Feature 2010-2 does meet the expectations for diversity described for the fall season. This feature has a low diversity value when measured with the Shannon-Weaver Index (H'=0.245), which is expected of individual fall features. Feature 2010-2 has the highest standardized density (N=30) of the Upward Sun River hearths, with the exclusion of the outlier, Feature 2014-5. The model expects fall archaeobotanical assemblages to have a medium to high density at base camps, and so the observations are consistent with expectations for a longer-term occupation at a base camp.

5.2.2 Feature 2014-5 (13,220-13,060 cal yr BP)

Feature 2014-5 consisted of heavily burned organic remains above oxidized sediment approximately 267-270 cm below the modern site surface (cm BS). Similar to Feature 2010-2, the abundance of migratory waterfowl and common bearberry in Feature 2014-5 suggests a late fall occupation. Common bearberry dominates the archaeobotanical assemblage for this feature (Table 5.5). A few seeds resembling the closely related red fruit or alpine bearberry are also present in the assemblage, in addition to sedge, cinquefoil, and willow species. Of the five identified taxa in Feature 2014-5, the model expects three in late fall assemblages (common bearberry, cinquefoil, and willow). Red fruit or alpine bearberries generally ripen earlier during the summer, though the berries can remain on the plant into the fall season. The model does not include sedge in any seasonal assemblage. However, this taxon could serve functional purposes and I discuss its presence in Chapter 6.

The low diversity value for this feature (*H'*=0.366) matches expectations for fall archaeobotanical assemblages. When compared to the densities of other features at the site, the extremely high standardized density (N=114.81) does meet expectations for a fall base camp. Overall, the dominance of a seasonally abundant, predictable resource (common bearberry) in the assemblage and a smaller portion comprised of other taxa do meet expectations for late fall assemblage content. This could indicate task-specific areas associated with plant processing and storing.

5.2.3 Summary of Component 1 Results

The common bearberry dominates the Component 1 assemblage and is 100% ubiquitous in the component features. This trend is opposite of expectations for fall occupations, which suggest low ubiquity values for taxa, relating to discrete plant-processing areas. However, with a sample size of only two features, the ubiquity value is not necessarily meaningful. In this case, the high ubiquity value and standardized counts for the common bearberry highlight the importance of the taxon to Component 1 site occupants. The archaeobotanical assemblage has a low diversity value (*H'*=0.375). This does not meet the expectations for fall occupations, which should have medium density due to the inclusion of seasonally abundant plant resources that are not typically stored. When applying diversity as a measure of diet breadth, the Component 1 occupants had a narrow diet breadth when considering plant resources alone.

While the component diversity and ubiquity values do not meet expectations, the dominance of a seasonally abundant, predictable resource (common bearberry) meets expectations for fall assemblage content. The low diversity values for individual features and the fact that the hearths are widely spaced with similar plant resources reinforces the interpretation of task-specific plant processing areas. The dominance of other seasonally abundant resources in the faunal assemblage, such as waterfowl, supports the hypothesis for specialized focus on seasonally abundant resources, resulting in a relatively narrow diet breadth. These trends could also result from the use of a limited range of taxa during a shorter-term occupation at the site. Although the high density of macrobotanical remains and the setting of the site in a productive ecotone with access to a variety of resources support the interpretation of Component 1 as a base camp, faunal and lithic evidence suggests a shorter-term occupation (Potter et al. 2008).

5.3 Component 3 (11,610-11,280 cal yr BP)

Component 3 contains transitional Late Pleistocene and Early Holocene features (Figure 5.6). Pollen records indicate a spread of open forests during this period, with aspen or balsam poplar interspersed with shrubs, grasses, and sedges (Anderson et al. 2004; Edwards et al. 2005). Component 3 contains the earliest evidence of mortuary behavior in northern North America, including a cremation hearth (Feature 2010-5) and a contemporaneous double infant burial (Feature 2011-13) and associated evidence of a residential structure dating to approximately 11,500 cal yr BP (Potter et al. 2011a, 2014). Seasonal availability of salmon and the presence of juvenile ground squirrels suggest mid- to late summer occupation as a residential camp, from which foraging groups dispersed to conduct subsistence activities (Potter et al. 2011a, 2014). Seven Component 3 features are the focus of macrobotanical analysis, based on the context of the features and the density of associated lithic and faunal remains (Table 5.6 and Figure 5.7).

Expectations of summer (June through August) archaeobotanical assemblage characteristics for the Late Pleistocene and Early Holocene should apply to Component 3. This model considers the summer as a time of opportunistic foraging for abundant, locally available plant resources around a central base camp. A summer division of labor with residential base camps in lowland, ecotone settings and logistical hunting camps in upland settings for bison procurement likely occurred (Glassburn 2015), which would allow foragers to exploit the widest array of resources. During the Younger Dryas and proposed times of resource stress (Potter et al. 2013), foragers may have relied more on predictable plant resources in addition to small game and waterfowl. During the summer, foragers may have behaved in fitness maximizing ways, looking for plant foods with high nutrient content and ignoring famine foods.

An archaeobotanical assemblage deposited during the summer at a base camp should contain a greater diversity and density of macrobotanical remains than a task-specific hunting camp. These trends would suggest longer occupations, return to the same central location, and repeated use of hearth features. In a base camp context, summer components should have a moderate to high diversity and density, reflecting the use of seasonally abundant plant taxa that were likely consumed soon after harvest. At the component-scale, immediate consumption events should produce high ubiquity values, reflecting generalized incorporation of macrobotanical remains into the archaeological record.

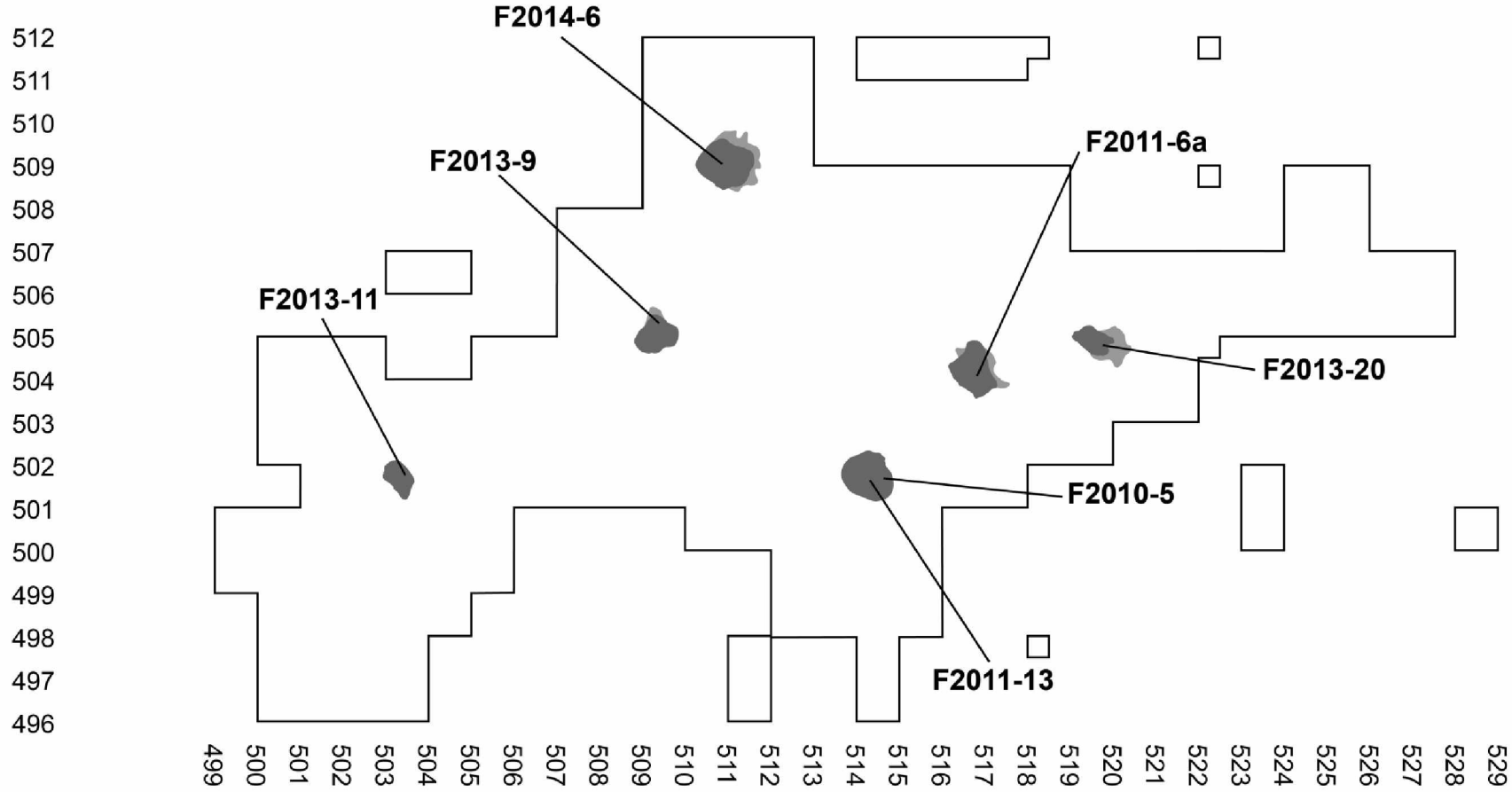

Figure 5.6 Component 3 Features. This plan view map shows the location of Features 2013-11, 2013-9, 2014-6. 2011-6a, 2013-20, 2010-5, and 2011-13 in Component 3 at the Upward Sun River site. The numbers lining the map refer to the arbitrary meter grid system established at the site to record provenience.

Table 5.6 Component 3 Macroremains. This table presents the raw (R) and standardized (S) counts for Component 3 features. Gelvin-Reymiller processed the cremation hearth Feature 2010-5 (Potter et al. 2007a, 2008). The burial pit Feature 2011-13 contained no macroremains and is not listed in this table. All other features are hearths. See Appendix B for species information. "Cf." refers to potential identifications.

	Component 3 Features											
	2010-5		2011-6A		2013-9		2013-11		2013-20		2014-6	
Taxon	R	S	R	S	R	S	R	S	R	S	R	S
Common bearberry	12	1.3	1	0.6	1	0.4	0	0	0	0	1	0.4
cf. common bearberry	3	0.3	0	0	0	0	0	0	0	0	0	0
Sedge sp.	8	0.9	0	0	1	0.4	0	0	0	0	0	0
cf. sedge sp.	3	0.3	0	0	0	0	0	0	0	0	2	0.9
cf. spruce sp.	0	0	0	0	1	0.4	0	0	0	0	0	0
Cinquefoil sp.	1	0.1	0	0	0	0	0	0	0	0	0	0
cf. nagoonberry	5	0.6	0	0	0	0	0	0	0	0	0	0
Heather family sp.	1	0.1	0	0	0	0	0	0	0	0	0	0
Rose family sp.	4	0.5	0	0	0	0	0	0	0	0	0	0
cf. marsh marigold sp.	1	0.1	0	0	0	0	0	0	0	0	0	0
cf. blueberry/low-bush cranberry sp.	1	0.1	30	16.6	0	0	0	0	0	0	10	4.4
cf. meadow rue sp.	0	0	1	0.6	0	0	0	0	0	0	0	0
Type 1 seeds	0	0	0	0	1	0.4	0	0	0	0	0	0
Unidentifiable seeds	12	1.3	2	1.1	3	1.3	1	0.5	3	2.6	1	0.4
Unidentified seeds	0	0	0	0	2	0.8	0	0	0	0	0	0
cf. willow sp. bud scale	0	0	4	2.2	0	0	0	0	1	0.9	0	0
cf. aspen/balsam poplar bud scale	0	0	2	1.1	0	0	0	0	0	0	0	0
Unidentified bud scales	10	1.1	1	0.6	5	2.1	3	1.6	0	0	7	3.1
Density (N)	61	6.8	41	22.6	14	5.8	4	2.2	4	3.6	21	9.2
Total Sed. Volume (L)	16.28		3.29		4.35		3.35		2.1		4.15	
Diversity (*H'*)	2.151		1.022		1.730		0.562		0.562		1.233	

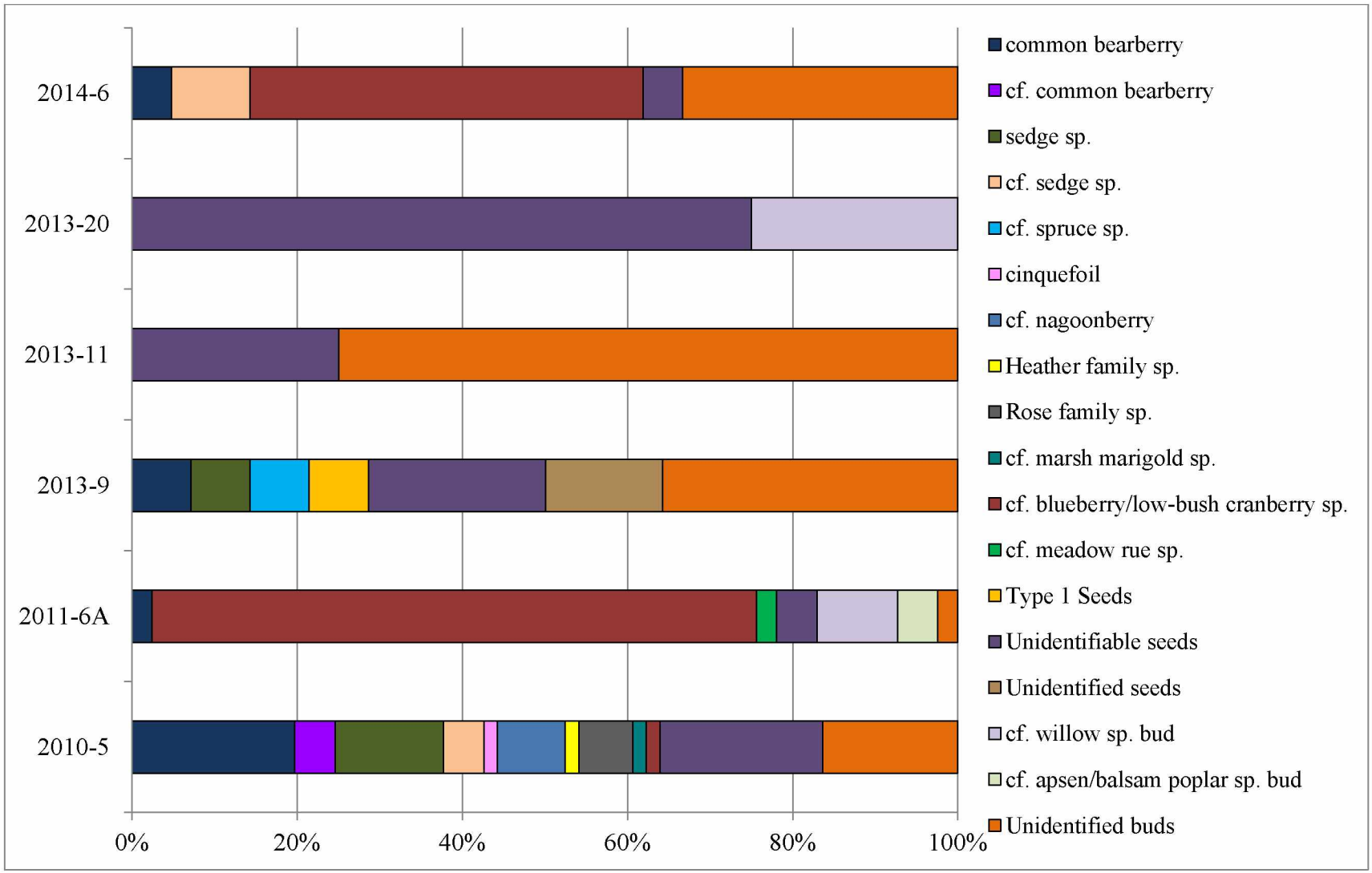

Figure 5.7 Percent Presence of Component 3 Macroremains. This figure illustrates the percent presence of plant taxa from the Upward Sun River Component 3 archaeobotanical assemblage. All features are hearths, except for the cremation Feature 2010-5, which was processed by Carol Gelvin-Reymiller. "Cf." refers to potential identifications.

5.3.1 Feature 2010-5 (11,750-11,260 cal yr BP)

Potter et al. (2011a) define Feature 2010-5 as a cremation pit found in association with lithic and faunal artifacts. Although the cremation remains make this feature unique, I include it for comparative purposes. Potter et al. (2011a) interpret the arc-shaped distribution of artifacts, six reddened post mold stains, and an approximate 27 cm depression in stratigraphy around the feature as evidence for a semi-subterranean residential structure. The feature was approximately 130x100 cm at the surface, 80x60 cm at the bottom, and 45 cm deep. Thick lenses of charcoal and oxidized sediment were present throughout the feature and around 37 cm of fill covered an oxidized layer containing the burned remains of an approximately 3 year old child. Beneath the human remains, a thinner charcoal-rich layer contained burned fish and small mammal bones. These remains likely relate to earlier use of the feature as a hearth and incorporation into the cremation fill when the pit was backfilled (Potter et al. 2011a). The presence of salmon and immature ground squirrel suggest a mid-July through early August occupation (Table 5.7).

Table 5.7 Faunal Remains from Features 2010-5 and 2011-13. This table is modified from Potter et al. (2014). NISP stands for the number of identified specimens. Percent NISP refers to the relative frequency of each taxon in the assemblage. Percent burn is the percentage of elements for each taxon that express evidence of burning.

	Feature 2010-5 (cremation hearth)			**Feature 2011-13** (burial pit)		
Taxon	**NISP**	**% NISP**	**% burn**	**NISP**	**% NISP**	**% burn**
Pisces						
Oncorhynchus sp. (salmonid)	308	37.2	96.1	29	28.2	27.6
Salmonidae (small salmonid)	18	2.2	100	7	6.8	0
Mammalia						
Urocitellus parryii (ground squirrel)	191	23.1	95.9	51	49.5	14.6
Lepus americanus (snowshoe hare)	46	5.6	100	2	1.9	0
Marmota sp. (marmot)	4	0.5	100	0	0	-
Sorex sp. (shrew)	1	0.1	100	0	0	-
Arvicolinae (vole and microtine)	231	27.9	99.6	14	13.6	28.6
Aves						
Tetraoninae (ptarmigan/grouse)	16	1.9	100	0	0	-
Paridae (passerine)	11	1.3	100	0	0	-
Avian, cf. Picidae	1	0.1	100	0	0	-
Total NISP	827	100		103	100	

Overall, eight plant taxa are identified in the feature's archaeobotanical assemblage. The presence of sedge and marsh marigold is not predicted for any season in the model. I included the taxa identified at the family-level (Heather and Rose family) when measuring feature diversity, though the classification is too broad to indicate seasonality. When considering expectations of assemblage content, nagoonberry and blueberry or low-bush cranberry species are expected in summer occupations. However, these taxa are also expected in fall occupations, in addition to the common bearberry and cinquefoil. The diversity value for Feature 2010-5 is the highest of the Upward Sun River site features (H'=2.151), which matches expectations for a summer assemblage. However, the low density of macrobotanical remains (N=6.8) does not meet the expectation for a high density for summer archaeobotanical assemblages.

5.3.2 Feature 2011-6A (11,310-11,210 cal yr BP)

Feature 2011-6A was approximately 80-83 cm BS, with heavily burned organic remains above oxidized sediment and woody charcoal fragments (Potter 2015, personal communication). The plant macroremains found in Feature 2011-6A include seeds from species such as common bearberry, a blueberry or low-bush cranberry species, and meadow rue. Willow and aspen or balsam poplar bud scales are also found in the feature's archaeobotanical assemblage. Several seeds and bud scales are unidentifiable or unidentified, though I still included them in the measure of diversity for the feature. The unidentifiable category refers to seeds that were recovered from feature matrix, but are too damaged or are not distinguishable enough to identify taxonomically. The unidentified category refers to seeds that were recovered from feature matrix that may be identifiable to the genus level but were not in this research due to time constraints.

Of the five taxa identified, the blueberry or low-bush cranberry species, willow, and aspen or balsam poplar species are expected in summer and fall assemblages. Meadow rue is not expected in any seasonal assemblage, though only one carbonized seed is present. The diversity value for Feature 2011-6A is medium to high (H'=1.022), while the standardized density is high (N=22.6). Overall, the assemblage content, diversity, and density for Feature 2011-6A are consistent with expectations for a summer base camp. Although the assemblage is dominated by a seasonally abundant and predictable plant resource (the blueberry or low-bush cranberry species), the diversity value for the feature is not consistent with expectations for processing and storage.

5.3.3 Feature 2011-13 (11,600-11,230 cal yr BP)

Potter et al. (2014) describe Feature 2011-13 as a double infant burial pit located 40 to 50 cm directly below the contemporaneous cremation hearth, Feature 2010-5. Although this feature is not defined as a hearth, I include it for comparative purposes. Skeletal evidence suggests that one individual died shortly after birth and the second individual was a late-term fetus (Potter et al. 2014). Grave goods include hafted bifaces with decorated antler fore-shafts. An ochre matrix at 121 to 129 cm below the site datum (cm BD) contained the remains. The fill from the pit contained some faunal and charcoal fragments, with little evidence for burning. A thin, organic-rich layer covered the infants and grave goods (Potter et al. 2014).

The limited faunal assemblage and the lower percentage of burned remains compared to the cremation pit suggests that the burial pit was not used before the internment of the infants (Table 5.7). Feature 2011-13 contained no macrobotanical remains, which contrasts with the high diversity of remains found in the cremation feature. This is either due to the fact that Feature 2010-5 was used for subsistence purposes before the cremation, while Feature 2011-13 was not, or the differences are the result of taphonomic bias. Carbonization of remains in Feature 2010-5 may have led to increased likelihood of preservation for plant remains, whereas Feature 2011-13 was not exposed to significant burning and any remains that were deposited would have less chance of preservation.

5.3.4 Feature 2013-9 (11,260-11,170 cal yr BP)

Feature 2013-9 was an oxidized hearth with heavily burned organic remains 70 to 80 cm BS (Potter 2015, personal communication). Three taxa are identified in the Feature 2013-9 archaeobotanical assemblage (Table 5.6), including common bearberry, sedge, and possibly white or black spruce. Tear-drop shaped seeds were found, though they are not taxonomically identifiable and were instead grouped into a single category of Type 1 seeds. Unidentified seeds and bud scales and unidentifiable seeds dominate the feature's assemblage. I disregarded the potential carbonized spruce seed because it could be contamination from recent forest fire debris in the upper soil horizons. Interior Alaskan pollen records suggest spruce was not abundant on the landscape until 6000 cal yr BP (Anderson et al. 2004; Bigelow 1997; Carlson and Finney 2004; Tinner et al. 2006). Even if the seed is directly associated with the hearth feature, spruce was likely not an important resource until it became more abundant on the landscape.

Of the three taxa identified, none are expected in a summer assemblage. The discrepancy between the expected and observed archaeobotanical assemblage complicates comparisons between the model and Feature 2013-9. The abundance of each taxon is relatively even and the diversity for the feature is high (*H'*=1.730). The statistical trends are consistent with summer expectations, when foragers are expected to behave in fitness maximizing ways and target a variety of nutrient-rich plant foods. However, the assemblage content is not consistent with fitness maximizing behavior and the only edible plant, common bearberry, does not ripen until early fall. The results from this feature do not support any hypotheses of seasonal assemblage content, which may be due to the quantity of unidentified or unidentifiable macroremains.

5.3.5 Feature 2013-11 (11,230-10,890 cal yr BP)

Feature 2013-11 extended from 85-91 cm BS (Potter 2015, personal communication). It consisted of heavily burned organic remains above oxidized sediment. Feature 2013-11 only contained unidentifiable seeds and bud scales. I include the standardized counts in the measure of diversity for the entire Component 3 assemblage. However, without identifiable taxa there is no way to compare the expectations of seasonal assemblage content. Overall, the feature has the lowest density of macrobotanical remains (N=2.2) and a low diversity value (*H'*= 0.562). These values are not consistent with expectations for base camps, but are consistent with task-specific camps. The low diversity and density values could indicate a shorter term occupation, that the feature was not repeatedly used, or that a limited range of activities occurred near the feature.

5.3.6 Feature 2013-20 (11,340-11,200 cal yr BP)

Feature 2013-20 was an oxidized hearth with charcoal and organic remains extending from 80-86 cm BS (Potter 2015, personal communication). This feature only contains a willow species bud and unidentifiable seeds (Table 5.6). Willow buds remain on the plant year round, which makes them poor seasonal indicators. I include the standardized counts for the feature in the overall calculation for Component 3 diversity, but there is no way to test hypotheses of seasonal foraging behavior without seasonal indicators. Similar to Feature 2013-11, Feature 2013-20 has a low density (N=3.5) and a low diversity value (*H'*= 0.562), which are not consistent with expectations for base camps. However, these trends could indicate limited activities and short-term use of the feature.

5.3.7 Feature 2014-6 (11,390-11,240 cal yr BP)

Feature 2014-6 was a hearth containing heavily burned organic remains above oxidized sediment with charcoal fragments, extending 85-95 cm BS (Potter 2015, personal communication). Only three taxa are identified for Feature 2014-6 (Table 5.6). Of the taxa identified, the blueberry or low-bush cranberry species is expected in the summer assemblage, while the common bearberry may be present on the landscape but is not expected in an assemblage until it ripens in early fall. A few potential sedge seeds, unidentifiable seeds, and unidentified bud scales are also present in Feature 2014-6.

This feature is similar to Feature 2011-6A in terms of assemblage content and diversity, with a moderate diversity value (H'= 1.233). However, the total density of macroremains is low to medium (N=9.2) for Feature 2014-6, while Feature 2011-6A has a high density (N=22.6). Despite the difference in density, similar trends exist in the evenness of taxon abundance and both archaeobotanical assemblages are dominated by a seasonally abundant and predictable resource (the blueberry or low-bush cranberry species). Feature 2014-6 density and diversity are more consistent with expectations for a fall archaeobotanical assemblage characteristics than summer. Overall, these data are consistent with expectations for a risk mitigating behavior, focusing on storable and predictable plant resources to potentially preserve for winter use.

5.3.8 Summary of Component 3 Results

The overall distribution of taxonomic abundance is relatively even for Component 3. The blueberry or low-bush cranberry species standardized values are among the highest in the component's archaeobotanical assemblage and the taxon is present in 50% of the features analyzed. These seeds dominate the assemblages for Features 2011-6A and 2014-6, which could indicate specialized activity areas meant for processing seasonally abundant berry taxa. The common bearberry and sedge (when combined with the potential sedge category) are both present in 67% of the Component 3 features in small quantities. The relatively high ubiquity percentage for these taxa could indicate that they were prevalent on the landscape and potentially used in a wide variety of contexts by site inhabitants. Willow species bud scales are present in 50% of the features analyzed. The remaining taxa are only present in one feature (17%) from Component 3.

The Component 3 assemblage has a high diversity value when calculated with the Shannon-Weaver Index (H'=1.907), which is consistent with expectations for summer occupations. The evenness of taxonomic abundance in some features and the unevenness in others could represent variation in associated activities and longer-term occupations that extend from the summer into early fall. Faunal evidence from Component 3 features suggests a mid-July through early August occupation, which encompasses the end of the summer season and the beginning of the fall season in the model of foraging behavior proposed in Chapter 4. Features such as 2010-5 and 2013-9 could reflect a transitional period during which site occupants continued opportunistic foraging for any resources available on the landscape earlier in the summer. In contrast, features such as 2011-6A and 2014-6 could indicate risk mitigating behavior, with an emphasis on a few predictable and storable resources (the blueberry or low-bush cranberry species) later in the summer and early fall when these species ripen.

5.5 Gerstle River Comparative Archaeobotanical Assemblage

This model proposed in this thesis suggests that plant resource exploitation should have less influence on the placement of shorter-term hunting camps than base camps due to site function and occupants. I compare the archaeobotanical assemblages from Upward Sun River and Gerstle River Component 3. Potter (2007) defines Gerstle River Component 3 as a logistically organized hunting camp. Bison and wapiti were processed at the site and high meat-yield elements were removed for transport back to a base camp (Potter 2007). Gelvin-Reymiller floated matrix from several hearth features from Gerstle River Component 3 (Potter 2005), offering a comparative archaeobotanical assemblage for the Upward Sun River site (Table 5.8 and Figure 5.8).

The presence of low-bush cranberry and wild raspberry seeds in the Gerstle River Component 3 assemblage suggest occupation in late summer or fall (Potter 2005). The seasonal model of plant resource exploitation suggests that if a summer or fall archaeobotanical assemblage is deposited, it should contain a lower diversity and density of macroremains than a base camp associated with longer-term occupations. Plant remains at task-specific camps likely represent opportunistic foraging and immediate consumption events while hunting and processing higher-return animal resources for transport to a base camp. In addition, high ubiquity values should represent generalized consumption of plants around any hearth feature at the site.

Table 5.8 Gerstle River Component 3 Macroremains. This table presents the raw (R) and standardized (S) counts of the Gerstle River Component 3 (10,160-9,910 cal BP) archaeobotanical assemblage, modified from Potter 2005 (683). Gelvin-Reymiller conducted the flotation and analysis. The raw counts are standardized based on the feature with the smallest amount of sediment processed for Gerstle River and Upward Sun River (Upward Sun River Component 1, Feature 2010-2 at 1.815 L), which allows for comparisons between features and components. For this comparison, I assume that the original identifications for Gerstle River plant remains are accurate and consistent with identifications from Upward Sun River.

	Feature							
	5		**10**		**12**		**14**	
Taxon	**R**	**S**	**R**	**S**	**R**	**S**	**R**	**S**
Vaccinium vitis-idaea low-bush cranberry	12	3.7	4	3.3	0	0	0	0
Betula sp. birch sp.	0	0	3	2.5	0	0	0	0
Rubus idaeus wild raspberry	0	0	1	0.8	0	0	0	0
Salix sp. willow sp.	0	0	0	0	2	0.6	2	0.7
Chenopodium album lamb's quarter, goosefoot	0	0	0	0	0	0	1	0.4
Poaceae, Cyperaceae, or Juncaceae grass, sedge, or rush	0	0	1	0.8	0	0	1	0.4
Buds	0	0	3	2.9	29	7.9	4	1.5
Density (N)	12	3.7	12	10.3	31	8.5	8	3
Total Sed. Volume (L)	5.9		2.19		6.66		4.99	
Diversity (*H'*)	0		1.474		0.239		1.213	

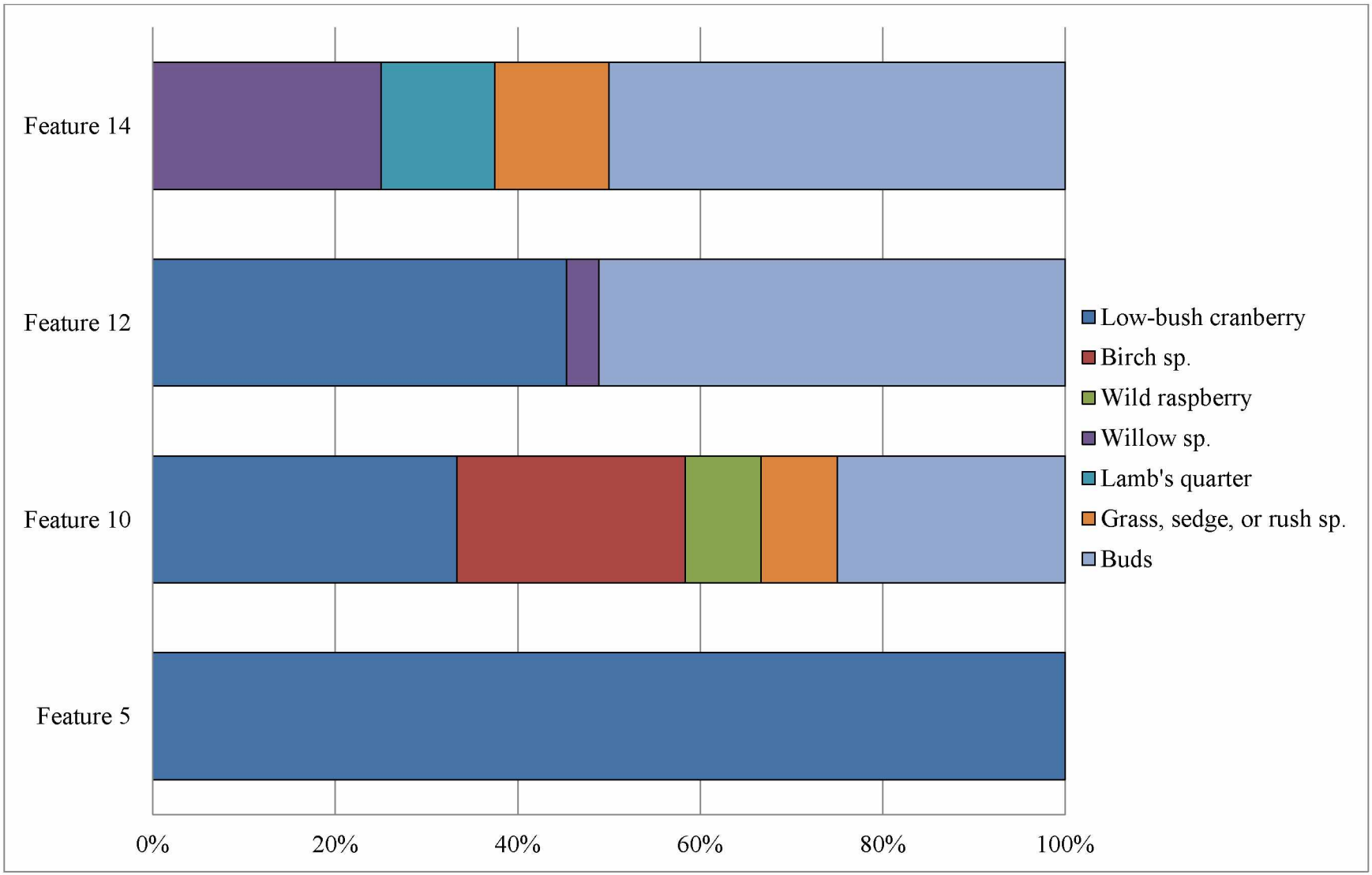

Figure 5.8 Percent Presence of Gerstle River Macroremains. This figure illustrates the percent presence of plant taxa from the Gerstle River Component 3 archaeobotanical assemblage.

The raw density of Gerstle River Component 3 (N=65) is less than the individual raw counts from Upward Sun River Component 1 (N=204) and Component 3 (N=145). When using the same parameters as Upward Sun River for density and diversity classifications, Gerstle River Features 5 and 14 have a low standardized density (N=3.7 and N=3, respectively). Gerstle River Features 10 and 12 have a low to medium standardized density (N=10.3 and N=8.5, respectively). Features 10 and 14 have a medium to high diversity (H'=1.474 and H'=1.213, respectively). Feature 12 has a low diversity value (H'=0.239) and Feature 5 has no diversity (H'=0). As a whole, Gerstle River Component 3 has a medium to high diversity (H'=1.339).

Assuming that the species-level identifications of edible taxa at Gerstle River are accurate, several trends are present with the edible taxa identified. Low-bush cranberry and wild raspberry are expected in both summer and fall assemblages, while lamb's quarter is not expected in any seasonal assemblage. Low-bush cranberry is present in small quantities in 50% of the features analyzed, while only one wild raspberry seed was recovered from Feature 10.

Buds are present in 75% of the features analyzed. Potter (2005) suggests that the buds may relate to the fuel source incorporated into the hearth features. Although low-bush cranberry and buds dominate the Gerstle River Component 3 archaeobotanical assemblage, their standardized counts are low (N=7 and N=12.3) when compared to taxa such as the common bearberry from Component 1 Feature 2014-5 at Upward Sun River (N=106.9). Although the dominance of a seasonally abundant and predictable species such as low-bush cranberry is consistent with expectations for fall processing and storage, the low density of the remains suggest that they likely represent immediate consumption events.

The medium to high diversity values for individual features and for Component 3 as a whole is not expected at logistical hunting camps, which should be less dense and diverse than base camps. Upward Sun River Components 1 and 3 have both high and low diversity values (H'=1.907 and H'=0.375, respectively). Overall, the diversity values are inconsistent with expectations of archaeobotanical assemblages at hunting camps, while the density values are consistent with expectations of immediate consumption. These results suggest that the model of Late Pleistocene and Holocene plant resource exploitation should be modified to account for the potential diversity in short-term hunting camp archaeobotanical assemblages.

Chapter 6

Research Implications

This research brings awareness to archaeobotanical datasets and contributes to research at the Upward Sun River site, which informs on aspects of domestic behavior that are under-conceptualized in Alaskan archaeology (Potter et al. 2011a, 2014). In the first section of this chapter, I detail the role of natural and anthropogenic deposition of plant remains and taphonomic problems associated with archaeobotanical assemblages in high-latitude contexts. In the second section, I discuss the implications of this research to our understanding of site seasonality in interior Alaska. Third, I consider the use of plant resources for edible, medicinal, and functional purposes and summarize the seasonal variability in plant and animal resources availability and nutritional content. Last, I describe the impact of plant foraging on land use, mobility, and settlement practices.

6.1 Deposition and Taphonomy

Establishing an association between plant remains and human activity requires contextual information. In general, direct association with anthropogenic features (such as hearths), relation with other archaeological material, and carbonization of botanical remains supports the argument for deposition when humans occupied the site. Contemporaneous dates for plant macroremains and features lend further support to this argument. The results from model testing provide a framework for thinking about research questions relating to deposition and taphonomy.

Are natural and anthropogenic deposits of plant remains at an archaeological site distinguishable? At the Upward Sun River site, excavators identified anthropogenic features through associated archaeological material (bone and lithic artifacts), charcoal, and oxidized sediment. Hearth matrix was focus of macrobotanical sampling because carbonized plant remains have greater preservation potential for Upward Sun River. However, the matrix from both mortuary features was included for comparative purposes. Appendix D lists the uncarbonized botanical remains recovered from hearth features. I considered these remains modern contamination and did not include them in the final analyses. In addition, I processed bulk samples that were originally gathered for phytolith and gastropod analysis as control samples for the Upward Sun River archaeobotanical assemblage (Appendix C). These data are useful for comparison between natural and anthropogenic deposits of plant macroremains.

As discussed in Chapter 3, distinguishing natural from anthropogenic deposits is difficult in Middle to Late Holocene components, which contain charcoal associated with the forest fires that can overlap with anthropogenic deposits and become indistinguishable. In contrast, Late Pleistocene and Early Holocene loess deposits at sites such as Upward Sun River allow for clearer distinction between natural and anthropogenic deposits of macroremains. In the context of Upward Sun River, oxidized sediment and charcoal associated with features was distinguishable from unaltered loess. The control samples (Appendix C) also highlight these trends, with a few macroremains in the upper forest soils and none in the lower loess deposits, which supports the association between carbonized remains and human activity.

What anthropogenic processes and activities lead to the deposition of plant remains at an archaeological site? A number of anthropogenic processes and activities can lead to the deposition and preservation of plant remains at an archaeological site. Understanding how plant remains are deposited in the record can indicate how the assemblages are biased. Considered in the context of the Upward Sun River site, all of the plant remains present are associated with hearth features or the mortuary features that were included in the analysis. As discussed in Chapter 5, there were no plant remains associated with the double infant burial (Feature 2011-13) and the plant remains from the cremation pit (Feature 2010-5) are assumed to be the contents of backfill from an older hearth (Potter et al. 2011a). This biased the assemblage in favor of plant taxa that were used in and around these features, whether through immediate consumption, cooking, or processing.

Overall, tree and shrub taxa should dominate archaeobotanical assemblages produced in hearth feature contexts because they have more hard parts, have multiple uses, are present year-round, and are intentionally introduced into hearth features as fuel (Gallagher 2014; Kari 1985; Kuhnlein and Turner 1991). Berry and fruit bearing taxa may also be present in a hearth feature assemblage, although not all berries and seeds have equal chances of preservation in the archaeological record. Taxa that have soft tissue and high water content have less of a chance of preservation than those with dense seeds and other hard parts (Minnis 1981). Leafy-green taxa generally do not have the hard parts that could withstand carbonization and leaves and soft parts decompose quickly (Gallagher 2014). Roots are difficult to identify in the archaeobotanical record, but they are generally processed before consumption, which increases the chance of deposition in hearth features (Kari 1985; Kuhnlein and Turner 1991).

What processes have impacted plant remains at the Upward Sun River site since deposition? Understanding post-depositional processes can illustrate potential biases in the record. Fragile blueberry or low-bush cranberry species seeds contribute a higher percentage (~11%) to the overall Upward Sun River archaeobotanical assemblage than robust seeds, such as nagoonberry (less than 1%). The preservation of fragile remains suggests that the features underwent minimal post-depositional disturbance, which would likely damage the remains. I expect the preservation of the common bearberry in greater quantities (~71% of the total assemblage) because the taxon is often processed before consumption or preservation and the seeds are dense and robust, suggesting that they would withstand carbonization and post-depositional processes better than more fragile remains.

Careless sampling and processing procedures can lead to contamination of samples with unrelated plant materials and damage or loss of fragile or very small plant materials (Dincauze 2000; Keepax 1977). These factors can impact the archaeobotanical assemblage and decrease the number of identifiable specimens in an assemblage. In addition, sample size can influence archaeobotanical assemblage characteristics. The analysis in Chapter 5 indicates that there may be a positive linear relationship between the amount of sediment processed and the diversity values for the Upward Sun River hearth features. In general, the greater the sample size of feature matrix processed, the greater the diversity of plant taxa identified. Overall, this suggests that multiple lines of evidence should be considered to strengthen interpretations of foraging behavior and to address the problem of equifinality.

6.2 Site Seasonality

Chapter 1 introduced several research questions relating to site seasonality and associated foraging activity. This section restates the original research questions and discusses the implications of model development and the results from the Upward Sun River site in understanding site seasonality during the Late Pleistocene and Early Holocene.

What seasonality does the Upward Sun River archaeobotanical assemblage indicate? Archaeobotanists often engage in macrobotanical analysis to determine the season of occupation at a site (Pearsall 2000). Many plants produce fruit or ripen at a particular time every year (Viereck and Little 2007). Identifying seasonal indicators in an archaeobotanical assemblage constrains the timing of site occupation. Ethnographic and modern hunter-gatherers commonly

preserve and store plant resources for later use (Kari 1985; Kuhnlein and Turner 1991). In addition, many berries and fruits over-winter on plants and foragers can gather them year round (Kuhnlein and Turner 1991). Preservation, storage, and over-wintering of plants complicate determinations of site seasonality.

At the Upward Sun River site, the presence of common bearberry in the Component 1 archaeobotanical assemblage suggests a late summer through fall occupation (August through October) for associated hearth features. The common bearberry ripens in August and ethnographic populations generally gather the plant's berries around this time (Kari 1985; Viereck and Little 2007). Plant remains from Component 3 suggest an extended stay for site occupants, ranging from mid-summer to fall. Species such as nagoonberry and bog blueberry ripen as early as July, although others such as common bearberry and low-bush cranberry ripen later in August (Viereck and Little 2007). Ethnographic populations tend to harvest low-bush cranberry after the first frost (Kari 1985; Kuhnlein and Turner 1991).

How does the seasonality indicated by the archaeobotanical evidence compare with other lines of evidence? Multiple lines of evidence strengthen inferences of site seasonality. Potter et al. (2008) suggest that the abundance of migratory waterfowl in Component 1 supports the interpretation of a fall occupation. Waterfowl are vulnerable during the early autumn molt and during staging for migration (Potter et al. 2008). The ethnographic record describes late spring through fall (May through October) as a time of waterfowl exploitation for many communities in interior Alaska (Andrews 1975; Hosley 1981; McKennan 1981; Shinkwin and Case 1984). The overlap in the timing of high waterfowl vulnerability and the ripening of common bearberry, in addition to the abundance of both in the floral and faunal assemblages from Component 1, supports the interpretation of an early fall occupation.

Remains from chum salmon (*Oncorhynchus keta*) are present in the Component 3 faunal assemblage (Halffman et al. 2015). Modern runs for this species of salmon occur in June and July in the Tanana Drainage Basin (Savereide and Huang 2014; Spencer and Eiler 2007). In addition, the presence of ground squirrels with unfused epiphyses suggests a mid-summer occupation (Potter et al. 2011a). Overall, the faunal evidence from Component 3 suggests a mid-July through early August occupation. The overlap in seasonal availability of faunal resources and berries that ripen throughout the summer and into early fall supports the interpretation of Component 3 as a mid- to late summer occupation.

How can seasonal differences in foraging behavior impact archaeobotanical assemblage content? Forager decision making likely varied in relation to seasonal availability and abundance of resources. Seasonal presence or absence of a plant taxon on the landscape determines the chance of its incorporation into the archaeological record. However, the presence of a plant taxon on the landscape during a particular season does not equate with that taxon's inclusion in the archaeological record. Cultural preference and classifications of specific resources as beneficial for a food or medicine can influence decisions to procure one resource over another.

For example, Turner and Davis (1993) note the difference in opinion of black tree lichen (*Bryoria* sp.) among northern populations. Some ethnographic populations used the taxon frequently and others considered it a famine food. Another example is the use of bearberries among ethnographic groups in Alaska. Some ethnographies note a preference for the common bearberry when preserved in fat (Holloway and Alexander 1990; Jones 2010; Kari 1985), but also state that indigenous populations considered it secondary to other berries and regarded it as a food for storage and use in the winter when other foods were scarce (Jones 2010; Kari 1985).

In this model, I assumed that foragers incorporated seasonally predictable plant resources into their diet to mitigate day-to-day risk associated with foraging for high-return, but less predictable, large mammal resources, in addition to seasonal risk associated periods of resource stress. Upward Sun River Components 1 and 3 do not contain direct evidence of storage (such as caches or baskets). However, the archaeobotanical assemblages from both components contain evidence for the procurement of seasonally abundant resources, including the common bearberry and a blueberry or low-bush cranberry species. The ethnographic record often associates these species with processing and storage (Jones 2010; Kari 1985; Kuhnlein and Turner 1991).

In Component 3, the blueberry or low-bush cranberry species is the most abundant (41 seeds total). The seeds are present in 50% of the features analyzed and dominate the assemblages for Features 2011-6A and 2014-6, which could indicate activity areas meant for consumption or processing. The small quantity of other plant taxa in Component 3 supports this interpretation. Floral and faunal remains suggest a mid- to late summer occupation. Features such as 2010-5 and 2013-9 could reflect mid-summer use, while site occupants continued to opportunistically forage for resources available on the landscape. Alternatively, Features 2011-6A and 2014-6 could indicate specialized emphasis on seasonally abundant and predictable resources, such as the blueberry or low-bush cranberry species, which ripen in late summer and early fall.

In Component 1, the high ubiquity value and large counts (190 seeds total) for the common bearberry suggest that the taxon was important to site occupants during the times that Feature 2010-5 and 2014-5 were in use. The dominance of this seasonally abundant and predictable resource meets expectations for fall assemblage content. The low diversity values for individual features and dominance of a single taxon in two features that are widely spaced reinforces an interpretation of task-specific areas. Although the determination of storage requires direct evidence, these data indicate that Components 1 and 3 site occupants took advantage of seasonally abundant resources, which contributed to dietary diversity and offered nutrients that are limited in animal foods. The following section discusses dietary contribution in greater detail.

6.3 Plant Resource Use

Differential preservation of plant remains, cultural resource preference, seasonal availability of plant taxa, and seasonal differences in foraging behavior are all factors that could produce the difference in diversity, evenness, and ubiquity observed between the Component 1 and 3 assemblages. Given the assumption that seasonal resource availability and associated foraging behavior produced the difference in the Component 1 and 3 archaeobotanical assemblages, there are several implications that the results have on our understanding of Late Pleistocene and Early Holocene subsistence strategies in interior Alaska. This section restates the research questions relating to plant resource use and considers the results from model development in comparison with the Upward Sun River assemblage.

How were plant resources used by site inhabitants? Inferences of plant resource use require contextual information and multiple lines of evidence to support hypotheses of associated human activity. Although the model considered functional aspects of plant resources, the results suggest the need for a broader framework to address the use of plant resources for structures, tools, and implements. This is partially related to the context of the remains; when considering features alone, it is difficult to determine if plant resources were used for functional purposes. However, hearths do provide a record of plant preference for fuel. Although the hearth features from the Upward Sun River site were not systematically sampled for charcoal identification, charcoal identifications conducted for radiocarbon dating suggests generalized use of woody taxa that were present on the landscape during the time periods of the respective components.

Of the tree and shrub species present, Kari (1985) notes the preference among interior Alaskan ethnographic populations for willow and alder wood to smoke fish, while aspen, balsam poplar, and spruce served as a source of fuel and raw material for structures and tools. During occupation at the Upward Sun River site, willow, shrub birch, and aspen or balsam poplar species dominated local vegetation communities (Ager 1983; Anderson et al. 2004; Bigelow 1997). The low diversity of tree and shrub taxa suggests that site occupants may have been less selective of fuel sources, though systematic sampling and identification of charcoal at the Upward Sun River site is necessary before making broader inferences of taxa selection for fuel.

In an analysis of hearth charcoal from a Thule occupation (AD 1500 and 1700) at Cape Espenberg, Alaska, Crawford (2012) notes the abundance of spruce, which constitutes around 61% of the charcoal assemblage, while willow species only contribute 16% of the assemblage. Driftwood serves as the primary sources of fuel in this region due to the scarcity of trees, which would influence the selection and availability of taxa (Alix 2005). Driftwood is closely linked to specific climatic and ecological conditions, such as floods, storms, currents and winds, and sea-ice (Alix 2005). These conditions affect the circulation and delivery of driftwood to the coast, resulting in changes in abundance and distribution of the wood (Alix 2005).

Archaeological evidence from ice-patches in the Yukon and Alaska reflects the importance of the introduction of woody taxa into the region for tools and structures (Alix et al. 2012; Hare et al. 2004; VanderHoek et al. 2012). For atl'atl dart shafts, birch (probably tree birch) is the most common raw material identified, followed by spruce (Hare et al. 2004). Arrow shafts are more often spruce, followed by birch (Alix et al. 2012; Hare et al. 2004). Without direct evidence of organic technologies at sites, it is impossible to draw conclusions about plant selection for tools and equipment.

The presence of sedge in the Upward Sun macrobotanical assemblages could relate to functional plant resource use or to natural deposition into the archaeobotanical record due to its abundance on the landscape (Anderson et al. 2004). When the sedge and potential sedge seed categories are combined, this taxon is present in small quantities in 67% of the features analyzed for Component 3 and in 50% of features analyzed for Component 1. The ethnographic record mentions use of sedge for mats and containers (Kari 1985; Kuhnlein and Turner 1991). However, the small quantity and dispersed nature of the remains suggests that they more likely reflect natural incorporation into the hearth features during the time that they were in use.

What does the diversity of edible and medicinal plants suggest about diet breadth? The Component 1 archaeobotanical assemblage is less diverse (H'=0.375) than the Component 3 assemblage (H'=1.907). The specialization with common bearberry suggests that site occupants chose to focus foraging efforts on abundant, predictable resources, resulting in a narrow diet breadth in terms of plant resources. The dominance of other seasonally abundant resources in the faunal assemblage, such as waterfowl, supports the hypothesis for specialized focus on seasonally abundant resources. However, this trend could also relate to shorter-term occupations and the use of a few taxa during site occupation.

When considering diversity as a measure of diet breadth, the high diversity value for the Component 3 archaeobotanical assemblage suggests a broad diet breadth given the plant resources alone. The faunal evidence also supports the interpretation of a broad diet breadth that included small mammals, waterfowl, and salmon (Potter et al. 2011a, 2014). Potter et al. (2011a) suggest that the occupants of the base camp foraged locally for animal resources, which were brought back to the site for processing. Opposite of Component 1, the trends in diversity values could relate to longer-term occupations and repeated feature use. This would result in greater diversity values that may not directly relate to dietary diversity.

Although large mammals were likely the main component that foragers relied upon to maintain adequate caloric intake during the Late Pleistocene and Holocene, research suggests that overall diet breadth was broad during many paleoenvironmental periods (Holmes 2001; Potter et al. 2013; Yesner 2001). Large mammals such as bison, wapiti, caribou, and moose all appear in the zooarchaeological record. In addition, small game, such as snowshoe hare and ground squirrel, migratory waterfowl, and anadromous and freshwater fish are all present and took on varying degrees of importance depending on fluctuations in large mammal abundance (Potter et al. 2013). This research argues that plants served as an important supplement to meat-oriented diets throughout the Late Pleistocene and Holocene, which would result in a broader diet breadth than when considering animal resources alone.

Do edible and medicinal plants provide nutrients not found in other foods? In Chapter 4, I discussed the nutritional content of plant and animal resources available in interior Alaska during the Late Pleistocene and Holocene. Access to nutrients likely varied throughout the year. During the summer and fall, bison may have provided the majority of animal fat and protein for Late Pleistocene and Early Holocene foragers. However, the results from Upward Sun River

Component 3 suggest a broad diet breadth dominated by salmon, small mammals, and birds. Similarly, the remains from Component 1 suggest a range of animal input into the diet of site occupants, dominated by waterfowl, but also including some large and small mammal remains.

Salmon, hare, and ground squirrel could provide nearly 40% of the daily recommended intakes of protein for males and females 19-30 years-old, though they provide less fat than bison at less than 10% of the daily recommended intake. Organs provide a wide variety of micro- and macro-nutrients. For example, caribou and moose liver provide 100% of the daily recommended intake for Vitamin A, in addition to large percentages of iron, copper, and riboflavin. A forager would have access to these organs whenever they had access to a fresh kill.

Summer and fall plant resource provide Vitamin C, with fireweed leaves and cloudberries contributing 100% of the daily recommended intakes, in addition micro-nutrients such as niacin, riboflavin, and thiamine. Plant foods generally contribute less than 10% of recommended daily caloric, protein, and fat intakes. During the fall, root foods could provide approximately 20% of recommended carbohydrate intake and the common bearberry could provide over half of the recommended daily fiber intake. The resources expected in summer and fall contribute minimally to recommended intakes for minerals such as potassium, magnesium, and calcium.

During the winter and spring, access to fresh, nutrient-rich resources was limited. Dried fish and caribou could provide copper and zinc, in addition to 100% of the recommended protein intake for adults 19-30 years old. Fat intake may have been minimal in late winter and early spring when animal fat reserves were depleted. In addition, resources such as small mammals, caribou, and fish have a high protein content and minimal fat. If access to fat was limited during late winter and spring months, then protein poisoning would have been a major concern for foragers relying on these resources.

Assuming that berries and fruits maintain similar nutritional values throughout the winter, over-wintering plants (such as crowberry and rosehips) could provide a large portion of recommended daily Vitamin C intakes for prehistoric foragers. There are no records pertaining to the nutritional values of famine foods that likely contributed to winter subsistence. By late spring, fresh plant foods would be available and there was likely a greater contribution of migrating waterfowl to the diet. Wild chives or onions and horsetail are harvested while young in the spring season (Kari 1985; Kuhnlein and Turner 1991) and could provide around 50% of recommended daily Vitamin C intake.

The nutritional data and evidence from Upward Sun River Components 1 and 3 suggest that the site's inhabitants had access to and foraged for a variety of plant an animal resources that allowed them to maintain fitness. However, the results also indicate that the model should place more emphasis on the impact of site type on faunal assemblage content. For example, Potter et al. (2011a) suggest that the remains at Upward Sun River represent broad-spectrum foraging, with groups foraging locally near a residential base camp. As mentioned previously, plant remains were likely collected locally around a central base camp, in addition to small mammals, waterfowl, and fish. Those remaining at a base camp would have a broader diet breadth and access to different nutrients, such as those listed above, than those primarily foraging from a short-term hunting camps focused on large mammal procurement. The next section considers the differences in site type and resource procurement.

6.4 Land Use

If plant resources made important contributions to the diet and were necessary for the creation of structures, implements, and tools, then these resources likely impacted decision making regarding the location of settlement and how often a camp moved. Concepts of residential and logistical mobility and central place foraging were incorporated into model expectations to discuss the relationship between site type and archaeobotanical assemblage characteristics. This section discusses the results from the Upward Sun River site and the implications of the model on land use.

Were identified plants available near the site during occupation? Or, were site inhabitants traveling greater distances to procure plant resources? The ecological tolerances of plant taxa present in the archaeobotanical assemblage from Upward Sun River are useful for reconstructing the basic vegetation communities that existed around the site. If some taxa present only grow in specific settings that are not expected to occur around the site, it is potentially an indication that site occupants were traveling to procure plant resources, as opposed to only foraging for immediately available resources. Modern habitats of the taxa present are within the range of expectations for the local area around the site in a well-drained setting, in inter-dunal areas that retain more moisture, or at nearby water sources (Appendix B). This suggests exploitation of a broad range of locally available resources.

How can plant resource exploitation influence settlement location and mobility? This model assumed that plant resources were collected within a close proximity to the central camp. This would necessitate the placement of the base camp in a location with access to multiple resources, particularly those that are difficult to transport (such as water) in addition to plant resources. In a highly seasonal environment, plant resource harvesting occurs during the summer and fall months. This supports the interpretation of summer base camps in ecotone areas, from which logistical task-groups could branch out to hunt large mammals (Glassburn 2015). Plant resource procurement would have less influence on the location of winter camps, as foragers likely relied upon preserved resources or fresh hunted foods. This suggests that groups could be more residentially mobile to accommodate resources that are mobile, dispersed, and unpredictable during the winter months (Jochim 1988).

Potter et al. (2011a) define Upward Sun River Component 3 as the remains of a residential base camp, from which logistical task-groups went on forays to conduct subsistence related activities. Overall, the diversity, density, and content of the archaeobotanical assemblage in Components 1 and 3 are consistent with expectations for a base camp. In addition, the setting of the site in a productive ecotone area with access to a wide variety of resources reinforces the interpretation of locally-based plant resource exploitation. The density of the plant remains in Component 1 and 3 features suggests longer term occupations and repeated hearth features use.

In comparison, Potter (2005, 2007) suggests that Gerstle River Component 3 represents a logistically organized hunting camp oriented around bison and wapiti procurement. If large mammal hunting and processing was the main purpose of the site, then plant resources should have less influence over its location and associated activities. Gerstle River Component 3 features contained macrobotanical remains such as low-bush cranberry, wild raspberry, and buds. Although the medium to high diversity associated the archaeobotanical assemblage from Component 3 does not meet the expectations for a task-specific camp, the low density values suggest that the plant remains likely represent opportunistic foraging and immediate consumption events while hunting and processing higher-return animal resources.

This comparison reflects the complex interaction between prehistoric foragers in their environments. The classification of site types and the expectations of associated archaeobotanical assemblages proposed in this model may be too rigid to fit the reality of foraging behavior. For example, Potter (2005) defines Gerstle River Component 3 as a logistical hunting camp, though

the goal of large game procurement was not so strict that foragers also did not allow themselves the time to collect low-return resources, such as berries. In addition, Yesner (1996) suggests that sites such as Broken Mammoth cannot be simply defined as hunting camps or long term base camps alone, but rather reflect a mix of activities including tool manufacture and maintenance, game processing, food consumption, hide processing and clothing manufacture, and other maintenance activities. These observations suggest that a broader range of site types and associated activity should be considered when addressing prehistoric foraging behavior. Consideration of multiple site types associated with different functions and occupants can inform on under-conceptualized aspects of prehistoric foraging behavior.

Chapter 7
Conclusions

In this thesis, I aimed to explore the relationship between plant resources and foraging behavior in interior Alaska and to address biases in high-latitude archaeology. Specific objectives included identifying macrobotanical remains from Upward Sun River, explaining patterns at the feature- and component-scale, and directly dating ecologically and culturally important plant taxa. To meet these objectives, this research applied standard paleoethnobotanical techniques to sample feature matrix in the field and the laboratory. Measures of density, diversity, and ubiquity identified trends in the macrobotanical assemblage. Seeds from culturally and economically important plants such as common bearberry, nagoonberry, and a blueberry or low-bush cranberry species were sent to Beta Analytic, Inc. for radiocarbon dating. This chapter concludes the discussion of archaeobotanical research, model development, and site-specific analysis at Upward Sun River.

The over-arching model developed in this thesis contextualized the results from Upward Sun River with regional archaeological, paleoecological, and ethnographic records. Archaeologists and paleoecologists debate the impact of global-scale climatic periods on local ecosystems and human occupation in interior Alaska (Bigelow and Powers 2001; Graf and Bigelow 2011; Kokorowski et al. 2008). Difficulties arise due to the different scales of archaeological and environmental datasets, in addition to the treatment of the environment as a static backdrop in archaeological reconstructions of past lifeways (Butzer 1980; Reuther 2013). Humans do not interact with long-term, global-scale climate change; rather, how they choose to structure their lives reflects response to local-scale ecosystem change on a day-to-day, seasonal, or annual time-scale (Reuther 2013). However, long-term environmental change impacts resource availability and associated subsistence, settlement, and technology.

The changes observed in the archaeological and paleoenvironmental records for interior Alaska reflect complex and varying degrees of interaction between human and environmental systems. For example, at the transition from the Late Pleistocene to the Early Holocene, ecological change led to fluctuation in habitat size and distribution for animals, particularly large mammal grazers. The combination of habitat reduction and possible over-predation by humans led to the extinction of some species in Alaska, such as mammoth and horse (Guthrie 2006; Potter et al. 2013). Another example is the opening of the Ice Free Corridor between the

Cordilleran and Laurentide Ice Sheets by 13,000 cal yr BP (MacDonald and McLeod 1996). The climatic amelioration during the Holocene may have made movement between Alaska, Canada, and central North America easier for human populations (MacDonald and McLeod 1996). Some suggest that after the initial colonization of the Americas, human populations migrating from the south brought Northern Archaic technology to Alaska (Morrison 1987; Workman 1978). Overall, these examples suggest that humans are often active agents of change to their own lifeways and to their surrounding environment.

Archaeobotanical analysis contributes to a holistic understanding of prehistoric behavior and the interaction between humans and the environment. In interior Alaska and northern contexts, this research evens out our understanding of the impact that both plant and animal resources had on prehistoric subsistence and settlement patterns. This research draws attention to aspects of human behavior that are under-conceptualized in Alaskan archaeology, such as the gender division of labor, domestic behavior, and potential impacts of plant resource exploitation on mobility and land use.

Furthermore, this research directly links archaeological and paleoenvironmental datasets. Macrobotanical analyses complement vegetation reconstructions provided by palynological analysis and can offer direct evidence of taxa that are under-represented or difficult to identify in the pollen record, such as tree and shrub birch (*Betula papyrifera* and *B. glandulosa*, respectively; Birks 2007). The presence of ecologically significant tree species in interior Alaska, such as aspen or balsam poplar (*Populus* sp.), has important implications regarding the development of forests in interior Alaska. In addition, the presence of economically important plant foods, including berries such as common bearberry (*Arctostaphylos uva-ursi*), blueberry or low-bush cranberry species (*Vaccinium* sp.), and a raspberry-genus species (*Rubus* sp.), has important implications on plant resource availability and contribution to prehistoric diets.

On a broader scale, paleoethnobotany and ethnobotany inform on practical applications of plant resources in day-to-day life. In *Traditional Plant Foods of the Canadian Indigenous Peoples*, Kuhnlein and Turner (1991) identify over 1,050 species of edible plants in Canada. For this research, I developed a database of over 300 species of edible, medicinal, and useful plants that are available in interior Alaska alone. In *Plants, People, and Culture: the Science of Ethnobotany*, Balick and Cox (1996) detail a list of 50 ethnobotanically derived drugs, many of which were recently identified. Understanding the broad-scale use of plant resources, both

spatially and temporally, can preserve knowledge of the natural world and to lead new discoveries of plants with applications to health and medicine.

Although paleoethnobotany and ethnobotany continue to advance as scientific disciplines, the contributions that they have to offer are not yet exhausted. This research demonstrates that, despite common misconceptions, macrobotanical remains preserve in the subarctic archaeological record and are useful for developing hypotheses regarding prehistoric human behavior. In addition, this research demonstrates the long-standing use of culturally, economically, and ecologically important plant species in interior Alaska. Despite the differences in behavior and land use patterns observed in the archaeological and ethnographic records, there is continuity in the use of birch, aspen or balsam poplar, and berry species. This suggests that, while cultural occupations of interior Alaska may have altered over time, there are some cross-cultural similarities in the use of plant resources available in the region.

The results from this thesis highlight the importance of archaeobotanical research in high-latitude archaeology. Continued archaeobotanical research at well-stratified sites with preserved organic remains could provide comparative datasets that would allow for broader interpretations of the relationship between plant resources and prehistoric foraging behavior. In addition, the results suggest that while macrobotanical analysis from hearth features is informative, it should include systematic sampling and identification of charcoal to gain a fuller understanding of plant resource use for purposes other than food. Finally, the discrepancies noted between the model expectations and the results from Upward Sun River and Gerstle River should be viewed as potential avenues for future research. Future comparison of the model to other interior Alaskan archaeobotanical assemblages could highlight unknown aspects of Late Pleistocene and Holocene foraging behavior.

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Appendices

Appendix A
Nutritional Data

Table A.1 Nutritional Values of Edible and Medicinal Plants of the North American Arctic and Subarctic.*

Taxon	Plant Portion	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Betula glandulosa	leaves	-	58	8.1	-	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	inner bark	-	43	3.1	-	14	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-
Betula neoalaskana	leaves and twigs	-	48	4.9	5.5	11.6	1.6	-	-	-	-	-	157	434	118	-	-	-	-	-	7.3	10.5
Viburnum edule	fruit	39	89	0.1	0.4	9.4	3.8	0.5	0	0.01	0.9	13.4	106	24	23	0.6	140	11.0	0.1	0.1	0.3	0.1
Cornus canadensis	berry	52	81	0.6	0.8	16.6	5.2	0.5	0.01	0.03	0.5	2.1	4	52	19	0.4	-	12.0	0.1	0.6	0.1	-
Sedum rosea	leaves	33	89	1.7	1.1	8.3	0.7	0.5	0.07	0.28	0.8	64	518	132	20	-	-	-	-	-	0.6	-
Juniperus communis	needles	-	-	12.8	-	-	-	-	-	-	-	167	-	500	260	-	1150	180	2.4	-	22	5.2
Elaeagnus commutata	berry	51	86	1.3	0.9	10.9	0.5	0.7	0.03	0.05	0.4	10	-	7	20	-	-	-	-	-	0.4	-
Shepherdia canadensis	berry	72	81	1.8	0.7	6.6	1.1	-	-	-	-	-	-	16	21	0.5	-	8	0.3	1.4	0.5	0.2

Table A.1 Continued Nutritional Values of Edible and Medicinal Plants of the North American Arctic and Subarctic.*

Taxon	Plant Portion	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Empetrum nigrum	berry	35	89	0.2	0.7	9.5	5.9	0.7	0.01	0.01	0.1	51	4.6	9	11	2.5	87	7.9	1.0	0.1	0.4	0.4
Equisetum arvense	greens	20	90	1	0.2	4.4	1.1	0.7	0	0.07	5.6	50	18	120	54	-	116	101	0.1	0.5	2.9	0.6
Arctous alpina	berry	-	-	-	-	-	-	-	-	-	-	52.5	30	-	-	-	-	-	-	-	-	-
Arctous rubra	berry	-	85	0.5	-	5.9	-	-	-	-	-	82.3	-	-	-	-	-	-	-	-	-	-
Arctostaphylos uva-ursi	berry	92	75	0.7	1.1	22.4	14.8	0.6	-	-	-	-	-	37	35	0.5	-	17	1.3	0.5	0.7	0.2
Ledum groenlandicum	leaves	1	100	0	0	0.2	-	0.1	0.01	0	0	0.3	0	215	93	3.7	9	73	2.4	2.4	184	45.4
Oxycoccus microcarpus	fruit	46	88	0.4	0.7	10.8	1.4	0.2	0.03	0.02	0.1	11	40	14	10	2.0	82	5	0.1	0.1	0.5	0.2
Vaccinium caespitosum	fruit	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	fruit	45	88	0.7	0.6	10.6	3.3	0.2	0.07	0.41	0.6	18.3	11.5	19	13	6	75	8	0.2	0.3	0.2	2.7

Table A.1 Continued Nutritional Values of Edible and Medicinal Plants of the North American Arctic and Subarctic.*																						
Taxon	**Plant Portion**	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Vaccinium vitis-idaea	fruit	62	82	0.7	0.7	14.9	1.4	0.5	0.02	0.08	0.4	21.2	0.9	13	11	0.1	98	6.6	0.1	6.1	0.2	2.9
Lupinus nootkatensis	roots	71	82	2	0.4	15.4	7.8	0.8	0.04	0.05	0.1	-	-	31	33	123	-	78.0	0.2	0.2	10.4	0.5
Hedysarum alpinum	roots	135	67.8	5.8	2.4	22.6	-	1.4	0.1	0.07	1.3	11	29	-	67	-	-	-	-	-	-	-
Allium schoenoprasum	greens	27	-	2.7	0.6	-	-	-	0.10	0.06	0.5	32	-	83	41	-	-	-	-	-	0.8	-
Epilobium angustifolium	leaves	44	87	3	0.8	6.3	6	2.7	0.04	0.86	1.4	99.0	572	13	166	50	251	70	0.2	0.9	2.7	0.1
	shoots	17	92	0.2	0.3	4	0.9	0.5	-	-	-	-	4	32	31	0.6	-	20	0.7	0.7	0.5	0.1
Epilobium latifolium	leaves	-	78	3	0.8	6.3	-	1.6	0.4	0.54	1.4	128	1700	13	89	-	-	-	-	-	2.1	-
Oxyria digyna	leaves	-	87	3.8	0.9	7.6	-	1.3	-	-	-	40	890	116	87	18	-	75	0.1	0.6	3.2	1.7

Table A.1 Continued Nutritional Values of Edible and Medicinal Plants of the North American Arctic and Subarctic.*

Taxon	Plant Portion	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Polygonum bistorta	leaves	-	-	3.3	0.4	1.4	1.1	0.7	-	-	-	158	-	99	50	2.8	240	80	-	-	4.1	0.7
	bulbs	-	-	1.7	0.2	1.8	0.6	0.3	-	-	-	-	-	11	44	3.8	71	33	-	-	2.3	0.4
	roots	81	77	3.9	0.2	16.1	0.6	0.3	0.01	0.04	0.1	16	-	11	44	3.8	71	33	-	-	2.3	0.4
Rumex arcticus	greens	42	90	2.3	0.7	6.5	1.1	0.8	0.9	0.54	1.1	68	1190	2	55	-	-	-	-	-	0.8	-
Athyrium filix-femina	greens	34	89	4.6	0.4	5.5	6	0.8	0.02	0.21	4.9	26.6	361	32	101	1	370	34	0.3	0.8	1.3	0.5
Dryopteris expansa	roots	74	81	0.7	0.5	16.5	6.5	1.0	0.06	0.04	0.6	-	0.3	34	38	-	-	68	0.3	0.3	4.2	0.3
Amelanchier alnifolia	berry	90	76	0.7	1.2	21.4	6.4	0.7	0.01	0.01	0.3	15.7	86	69	40	0.6	244	26	0.4	0.5	2.2	-
Fragaria virginiana	berry	32	89	0.7	0.6	7.7	2.1	0.7	0.03	0.07	0.6	5.9	8	43	25	1.0	164	13	0.05	0.14	1.0	0.4
Potentilla anserina	roots	132	66	3.1	0.6	29.5	9.5	0.9	0.01	-	2.4	-	0.2	37	109	65	-	60	1.1	1.1	6.5	0.8

Table A.1 Continued Nutritional Values of Edible and Medicinal Plants of the North American Arctic and Subarctic.*

Taxon	Plant Portion	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Potentilla fruticosa	leaves	-	-	-	-	-	9.6	0.5	-	-	-	-	-	520	190	-	-	-	-	-	-	-
Rosa acicularis	fruit	55	65	2.4	0.7	21.3	-	2	0.12	0.1	1.1	1481	263	-	-	-	-	-	-	-	-	-
Rubus arcticus	berry	-	-	-	-	-	-	-	-	-	-	33.8	11	-	-	-	-	-	-	-	-	-
Rubus chamaemorus	berry	50	84	2.4	0.8	9.6	6	1.2	0.05	0.07	0.9	130	21	17	53	0.6	231	40.8	0.1	0.7	0.4	0.5
Rubus idaeus	berry	65	83	0.6	0.8	15.8	4.5	0.5	0.03	0.09	0.1	22.3	13	36	38	0.4	175	26	0.5	0.6	1.0	2.8
Populus balsamifera	bark	230	49	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Populus tremuloides	bark	-	41	1.3	-	-	31.7	1.6	-	-	-	-	-	684	17	1.8	130	53.1	0.5	8.3	4.4	1.2
Salix spp.	leaves	122	66	5.1	1.6	28	3.3	2.8	0.09	0.19	2.3	41	1830	268	127	-	472	-	0.2	2.9	2.6	0.1
	buds	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-	-	-	-	-

Table A.1 Continued Nutritional Values of Edible and Medicinal Plants of the North American Arctic and Subarctic.*

Taxon	Plant Portion	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Ribes glandulosum	fruit	-	-	-	-	-	-	-	-	-	-	55	-	-	-	-	-	-	-	-	-	-
Ribes hudsonianum	fruit	-	-	-	-	-	-	-	-	-	-	41	-	-	-	-	-	-	-	-	-	-
Ribes lacustre	fruit	59	86	1.5	2.3	9.7	3.5	0.9	0.04	0.01	0.1	58.2	3	68	47	0.6	275	22	0.1	0.2	0.4	0.3
Ribes oxyancanthoides	fruit	58	82	1	0.3	14.6	1.9	0.7	0.04	0.05	0.1	41	4.2	91	83	0.3	613	28.4	0.1	0.3	0.9	0.3
Ribes triste	fruit	-	-	-	-	-	-	-	-	-	-	51.5	-	-	-	-	-	-	-	-	-	-
Typha latifolia	rhizomes	-	9	7.7	4.9	79.1	-	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	greens	-	90	0.6	-	-	-	-	-	-	-	-	-	51	10	16	59	44	0.1	0.3	0.7	1.7
	shoots	25	93	1.2	0	5.1	4.5	1	0.02	0.02	0.44	0.7	1.1	54	45	109	309	63	0.04	0.2	0.9	0.8
	seeds	-	9	7.7	4.9	79.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heracleum lanatum	greens	-	91	1.6	-	-	-	1.5	-	0.11	-	-	-	-	-	-	-	-	-	-	-	-
	stalks	20	95	0.4	0.2	3.8	0.9	0.6	0.01	0.12	0.3	3.5	7.5	28	19	0.5	-	11.7	0.4	0.4	0.3	0.1

* All nutrient values were measured from 100 g of the respective plant portions and are listed in Kuhnlein and Turner (1991), Nobmann (1993), and the United States Department of Agriculture National Nutrient Database for Standard Reference (2015).

Table A.2 Nutritional Values of Game Bison (*Bison bison*) Portions. (USDA 2015)

Preparation	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Pan-broiled	238	59.5	23.8	15.1	0	0	1.02	0.13	0.25	5.57	0	0	13	205	73	341	22	0.15	5.1	3.1	0.01
Raw	223	64.3	18.7	15.9	0	0	0.88	0.13	0.23	4.91	0	0	11	181	66	307	19	0.13	4.3	2.6	0.01
Lean meat, roasted	143	66.5	28.4	2.4	0	0	1.58	0.10	0.27	3.71	0	0	8	209	57	361	26	0.11	3.7	3.4	0.01
Lean meat, raw	109	74.6	21.6	1.8	0	0	1.2	-	0.09	1.91	0	0	6	187	54	343	25	0.09	2.8	2.6	0.01

Table A.3 Nutritional Values of Game Black Bear (*Ursus americanus*) Portions. (USDA 2015)

Preparation	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Raw	155	71.2	20.1	8.3	0	-	0.4	0.16	0.68	260	-	78.78	-	162	-	-	-	-	-	7.2	-

Table A.4 Nutritional Values of Game Caribou (*Rangifer tarandus*) Portions. (USDA 2015)

Preparation	Food Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude Fiber (g)	Ash (g)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Vitamin A (RE)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Copper (mg)	Zinc (mg)	Iron (mg)	Manganese (mg)
Bone marrow, raw	786	7.4	6.7	84.4	0	-	1.5	0.04	-	0.2	-	72.7	-	107	-	-	-	-	-	4.5	-
Eye, raw	326	57.1	10.8	31.4	0	-	0.6	0.01	0.05	0.2	-	121.2	19	58	-	-	-	-	-	4.7	-
Hind quarter, cooked	159	65.5	28.8	4.8	0	0	1.1	0.29	0.81	5.89	0	94	5	215	45	245	24	0.33	4.3	4.8	0.04
Hind quarter, raw	112	72.6	22.6	3.4	0	0	1.2	0.44	0.96	7.15	0	94	5	230	52	320	26	0.27	2.1	4.1	0.04
Raw	127	71.5	22.6	3.4	0	0	1.1	0.32	0.72	-	0	0	17	208	57	295	26	0.22	4	4.7	0.08
Roasted	167	62.4	29.8	4.4	0	0	1.5	0.25	0.90	5.79	3	0	22	233	60	310	27	0.26	5.3	6.2	0.09
Rump, dried	255	38	52.1	5.2	0	0	3.2	0.33	1.24	13.20	0	52	14	480	390	710	60	0.60	9.4	11	0.10
Shoulder, dried	271	33.8	59.4	3.7	0	0	4.7	0.31	1.30	14.80	0	11	14	550	950	810	62	0.78	9.4	11	0.11
Stew	41	90	3.8	0.7	4.8	0.1	0.7	0.02	0.01	0.27	1.5	487	7	12	72	84	5	0.03	0.1	0.2	0.08
Liver, raw	122	71	15	3.9	6.8	-	2.9	-	-	-	-	8727	4	282	-	-	-	-	-	15.7	-

Table A.5 Nutritional Values of Game Ruffed Grouse (*Bonasa umbellus*) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Meat, raw	112	72.9	25.9	0.88	0	0	1.07	0.04	0.28	11.60	0	5	5	229	50	311	32	0.06	0.51	0.58	0.016

Table A.6 Nutritional Values of Game Long-Tailed Ground Squirrel (*Citellus undulates*) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Meat, raw	111	75.4	19.3	3.80	0	-	1.50	-	-	-	-	66.7	-	175	-	-	-	-	-	4.70	-

Table A.7 Nutritional Values of Game Elk (*Cervus elaphyus*) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Lean meat, broiled	167	64.5	31	3.84	0	0	1.14	0.16	0.33	8.98	0	0	5	256	54	404	28	0.17	5.1	3.96	0.01
Roasted	146	66.3	30.2	1.9	0	1.9	1.32	-	-	-	0	0	5	180	61	328	24	0.14	3.16	3.63	0.01

Table A.8 Nutritional Values of Game Moose (*Alces alces*) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Stew	55	86.1	6.6	0.5	6	0.5	0.8	0.06	0.08	-	1.0	316	12	16	222	100	6	0.02	0.12	1.52	0.09
Liver, braised	155	66	24.4	4.89	3.43	-	1.30	0.20	4.10	10.72	22.6	2909	7	429	70	235	20	2.80	6.07	6.77	0.41
Meat, raw	103	74.8	22.3	1.50	0	0	1.41	0.07	0.24	5.00	4.0	0	5	165	65	317	23	0.07	2.80	3.28	0.01
Meat, roasted	134	67.8	29.3	0.97	0	0	1.49	0.05	0.34	5.26	5.0	0	6	176	69	334	24	0.08	3.68	4.22	0.01

Table A.9 Nutritional Values of Game Rabbit (*Sylvilagus* sp.) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Meat, raw	114	74.5	21.8	2.32	0	0	1.12	0.03	0.06	6.5	0	0	12	226	50	378	29	-	-	3.2	-

Table A.10 Nutritional Values of Fish Chum Salmon (*Oncorhynchus keta*) Portions. (USDA 2015)																					
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Dried	378	22.8	62.1	14.38	0	0	-	0.36	0.46	14.65	0	16	155	650	190	910	68	-	1.40	2.20	-
Raw	116	72.3	20.7	3.67	0	0	1.27	0.16	0.22	8.790	0	32	7	230	59	370	26	0.14	0.54	0.56	0.03

Table A.11 Nutritional Values of Fish Chinook Salmon (*Oncorhynchus tshawytscha*) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Kippered, canned	266	51.2	30.7	15.90	-	-	-	0.05	0.14	10.90	-	15.2	38	-	-	-	-	-	-	1.70	-
With skin, kippered	209	61.5	23.2	12.95	0	0	3.21	0.04	0.20	8.61	0	12	55	270	870	390	29	0.148	0.77	0.55	0.04
Liver	156	69.8	16.6	8	4.3	-	1.30	0.10	0.70	5.00	-	951.5	28	412	-	-	-	-	-	2.60	-
Raw	187	65.9	20.3	11.73	0	-	1.25	0.16	0.17	8.42	0	136	42	208	48	370	24	-	0.52	0.79	-
Smoked, brined	430	23.6	39.9	30	0	0	3.60	0.06	0.28	11.80	-	159.7	23	-	693	700	-	-	-	4.50	-
Smoked, canned	150	66.7	23.2	5.90	0	-	3.20	0.01	0.10	8.50	-	96.7	60	-	-	-	-	-	-	1.80	-

Table A.12 Nutritional Values of Fish Coho Salmon (*Oncorhynchus kisutch*) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Raw	140	69.4	22.6	5.57	0	0	1.24	0.15	0.19	7.93	0	30	5	240	58	380	28	0.05	0.41	0.55	-

Table A.13 Nutritional Values of Fish Whitefish (*Coregonus* sp.) Portions. (USDA 2015)																				
Preparation	**Food Energy (kcal)**	**Water (g)**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Dried	371	20.6	62.4	13.44	0	0	5.57	0.05	0.44	11.2	0	39	810	1040	200	1080	85	0.18	5	4.10	0.23
Eggs	104	76.2	14.7	2.88	4.89	0	1.33	0.09	0.40	0.96	12.0	91	46	306	160	190	30	0.22	2.1	5.95	0.22

Table A.14 Nutritional Values of Agutuk AK Ice Cream with Caribou (*Rangifer tarandus*) Portions. (USDA 2015)

Preparation	Mixture
Food Energy (kcal)	258
Water (g)	55.2
Protein (g)	21.7
Fat (g)	18.60
Carbohydrate (g)	0.90
Crude Fiber (g)	-
Ash (g)	3.60
Thiamine (mg)	0.18
Riboflavin (mg)	0.66
Niacin (mg)	4.26
Vitamin C (mg)	2.2
Vitamin A (RE)	169.4
Calcium (mg)	16
Phosphorus (mg)	170
Sodium (mg)	95
Potassium (mg)	228
Magnesium (mg)	20
Copper (mg)	0.19
Zinc (mg)	3.83
Iron (mg)	4.55
Manganese (mg)	0.06

Table A.15 Recommended Daily Dietary Allowances and Intakes for Key Nutrients. (NAS 2011)																				
Life Stage	**Food Energy (kcal)****	**Water (L)**	**Protein (g)**	**Fat (g)*****	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Infants																					
0-6 mo	-	0.7	9.1	31	60	-	-	0.2	0.3	2	40	400	200	100	120	400	30	0.20	2	0.27	0.01
6-12 mo	-	0.8	11.0	30	95	-	-	0.3	0.4	4	50	500	260	275	370	700	75	0.22	3	11	0.6
Children																					
1-3 y	1200	1.3	13	47	130	19	-	0.5	0.5	6	15	300	700	460	1000	3000	80	0.34	3	7	1.2
4-8 y	1400	1.7	19	50	130	25	-	0.6	0.6	8	25	400	1000	500	1200	3800	130	0.44	5	10	1.5
Males																					
9-13 y	1800	2.4	34	69	130	31	-	0.9	0.9	12	45	600	1300	1250	1500	4500	240	0.70	8	8	1.9
14-18 y	2400	3.3	52	77	130	38	-	1.2	1.3	16	75	900	1300	1250	1500	4700	410	0.89	11	11	2.2
19-30 y	2500	3.7	56	80	130	38	-	1.2	1.3	16	90	900	1000	700	1500	4700	400	0.90	11	8	2.3
31-50 y	2400	3.7	56	77	130	38	-	1.2	1.3	16	90	900	1000	700	1500	4700	420	0.90	11	8	2.3
51-70 y	2200	3.7	56	73	130	30	-	1.2	1.3	16	90	900	1000	700	1300	4700	420	0.90	11	8	2.3
>70 y	2000	3.7	56	65	130	30	-	1.2	1.3	16	90	900	1200	700	1200	4700	420	0.90	11	8	2.3

Table A.15 Continued Recommended Daily Dietary Allowances and Intakes for Key Nutrients. (NAS 2011)																					
Life Stage	**Food Energy (kcal)****	**Water (L)**	**Protein (g)**	**Fat (g)*****	**Carbohydrate (g)**	**Crude Fiber (g)**	**Ash (g)**	**Thiamine (mg)**	**Riboflavin (mg)**	**Niacin (mg)**	**Vitamin C (mg)**	**Vitamin A (RE)**	**Calcium (mg)**	**Phosphorus (mg)**	**Sodium (mg)**	**Potassium (mg)**	**Magnesium (mg)**	**Copper (mg)**	**Zinc (mg)**	**Iron (mg)**	**Manganese (mg)**
Females																					
9-13 y	2000	2.1	34	65	130	26	-	0.9	0.9	12	45	600	1300	1250	1500	4500	240	0.70	8	8	1.6
14-18 y	2400	2.3	46	77	130	26	-	1.0	1.0	14	65	700	1300	1250	1500	4700	360	0.89	9	15	1.6
19-30 y	2400	2.7	46	77	130	25	-	1.1	1.1	14	75	700	1000	700	1500	4700	310	0.90	8	18	1.8
31-50 y	2200	2.7	46	73	130	25	-	1.1	1.1	14	75	700	1000	700	1500	4700	320	0.90	8	18	1.8
51-70 y	2200	2.7	46	73	130	21	-	1.1	1.1	14	75	700	1000	700	1300	4700	320	0.90	8	8	1.8
>70 y	2000	2.7	46	65	130	21	-	1.1	1.1	14	75	700	1200	700	1200	4700	320	0.90	8	8	1.8
Pregnancy																					
14-18 y	2700	3.0	71	90	175	28	-	1.4	1.4	18	80	750	1300	1250	1500	4700	400	1.0	12	27	2.0
19-30 y	2700	3.0	71	90	175	28	-	1.4	1.4	18	85	770	1000	700	1500	4700	350	1.0	11	27	2.0
31-50 y	2700	3.0	71	90	175	28	-	1.4	1.4	18	85	770	1000	700	1500	4700	360	1.0	11	27	2.0
Lactation																					
14-18 y	2400	3.8	71	77	210	29	-	1.4	1.6	17	115	1200	1300	1250	1500	5100	360	1.3	13	10	2.6
19-30 y	2400	3.8	71	77	210	29	-	1.4	1.6	17	120	1300	1000	700	1500	5100	310	1.3	12	9	2.6
31-50 y	2400	3.8	71	77	210	29	-	1.4	1.6	17	120	1300	1000	700	1500	5100	320	1.3	12	9	2.6

**Recommended requirements for individuals with a high activity level.
***Generalized for all life stages based on recommended daily caloric intakes.

Appendix B

Floral and Faunal Resources

Floral Resources

Betulaceae

Betula spp.

Latin name: *Betula glandulosa*

Common names: Dwarf birch, scrub birch, resin birch

Habitat: Moist and wet environments, such as swamps, bogs, muskegs; borders of lakes and streams; hummocks on tundra; creates widespread thickets at tree-line (Hultén 1968; Viereck and Little 2007).

Parts used (use): Inner bark, leaves, wood (edible, medicinal, functional).

Seasonality: Year-round use.

Potential macrofossils: Woody portions, buds and bud scales, bracts.

References: Andre and Fehr 2001; Clark 2012; Griffin 2001; Jones 2010; Kari 1995; Marles 1984; Turner 1997; Uprety et al. 2012

Latin name: *Betula neoalaskana* (formerly *Betula papyrifera*)

Common names: Paper birch, Alaska paper birch

Habitat: Warm slopes with well-drained soil; common up to tree-line in interior Alaska; can occur on north-facing slopes and in poorly-drained areas following fires (Hultén 1968; Viereck and Little 2007).

Parts used (use): Leaves and twigs, cambium, wood, bark (edible, functional).

Seasonality: Year-round; sap and cambium gathered in May.

Potential macrofossils: Woody portions, buds and bud scales, bracts.

References: Andrews 1975; Baldwin 1986; Clark 2012; Clavelle 1997; Gottesfeld 1993; Halpin 1987; Holloway and Alexander 1990; Jones 2010; Kari 1985; Marles 1984; Marles et al. 2000; Oswalt 1957; Rooth 1971; Shinkwin and Case 1984; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995

Alnus spp.

Latin name: *Alnus* spp.

Common names: Various alder species

Habitat: Variable depending on species; common in thickets along rivers and streams; moist soils (Viereck and Little 2007)

Parts used (use):

Seasonality: Year-round use.

Potential macrofossils: Woody portions, buds and bud scales.

References: Andre and Fehr 2001; Baldwin 1986; Clark 2012; Garibaldi 1999; Holloway and Alexander 1990; Kari 1985, 1995; Marles 1984; Marles et al. 2000; McIntosh 1999; Oswalt 1957; Uprety et al. 2012; Wennekens 1985

Caprifolaceae

Viburnum sp.

Latin name: *Viburnum edule*

Common names: High-bush cranberry, mooseberry, Pembina, squashberry, low-bush cranberry

Habitat: Occurs in along streams, in open forests, and thickets (Hultén 1968; Viereck and Little 2007).

Parts used (use): Fruit, bark (edible, medicinal).

Seasonality: Berries ripen in late July and August; berries can over-winter on the plant.

Potential macrofossils: Woody portions, berry seeds.

References: Andrews 1975; Baldwin 1986; Clark 2012; Garibaldi 1999; Gottesfeld 1993; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, Kari 1995; Marles 1984; Marles et al. 2000; Martin 1983; McKennan 1981; Olson 1968; Osgood 1937; Oswalt 1957; Rooth 1971; Shinkwin and Case 1984; Thorton 1999; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995; Wennekens 1985

Cornaceae

Cornus sp.

Latin name: *Cornus canadensis*

Common names: Bunchberries, creeping dogwood, Canada bunchberry

Habitat: Common in clearings of spruce and birch forests in interior Alaska (Hultén 1968; Johnson et al. 1995).

Parts used (use): Berry (edible).

Seasonality: Berries ripen in late July to September.

Potential macrofossils: Seeds.

References: Anderson 1939; Andrews 1975; Baldwin 1986; Clark 2012; Garibaldi 1999; Gottesfeld 1993; Kari 1995; Marles 1984; Marles et al. 2000; Turner 1997; Uprety et al. 2012; Wennekens 1985

Crassulaceae

Sedum sp.

Latin name: *Sedum rosea* (syn. *Rhodiola rosea*)

Common names: Roseroot, stonecrop

Habitat: Occurs in dry rocky places; in crevices of rocks and cliffs (Hultén 1968).

Parts used (use): Leaves (edible, medicinal).

Seasonality: Leaves gathered in early summer.

Potential macrofossils: No hard parts.

References: Ainana and Zagrebin 2014; Baldwin 1986; Garibaldi 1999; Griffin 2001; Heller 1953; Jones 2010; Kari 1995; McIntosh 1999; Young and Hall 1969

Cupressaceae

Juniperus sp.

Latin name: *Juniperus communis*

Common names: Common mountain juniper

Habitat: Scattered to rare in interior Alaska; well-drained rocky or sandy areas; forest openings (Hultén 1968; Viereck and Little 2007).

Parts used (use): Needles, fruits (medicinal).

Seasonality: Year-round use.

Potential macrofossils: Woody portions, berry seeds.

References: Andre and Fehr 2001; Clark 2012; Garibaldi 1999; Gottesfeld 1993; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995

Elaeagnaceae

Elaeagnus sp.

Latin name: *Elaeagnus commutata*

Common names: Silverberry, wolf-willow

Habitat: Forms thickets on sand and gravel bars along rivers; rocky, well-drained, south-facing slopes (Hultén 1968; Viereck and Little 2007).

Parts used (use): Berry (edible).

Seasonality: Berries present on plant fall through winter.

Potential macrofossils: Berry seeds, woody portions.

References: Andrews 1975; Baldwin 1986; Heller 1953; Holloway and Alexander 1990; Kari 1985, 1995; Marles et al. 2000; Turner 1997

Shepherdia sp.

Latin name: *Shepherdia canadensis*

Common names: Soapberry, buffaloberry, soopolallie

Habitat: Forms thickets on gravel bars along rivers; well-drained, south-facing slopes; dry, open, upland forests in interior Alaska (Hultén 1968; Viereck and Little 2007).

Parts used (use): Berry (edible, medicinal).

Seasonality: Berries ripen July to August.

Potential macrofossils: Berry seeds, woody portions.

References: Andre and Fehr 2001; Baldwin 1986; Clavelle 1997; Garibaldi 1999; Gottesfeld 1993; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Thorton 1999; Turner 1997; Uprety et al. 2012; Viereck 1987

Empetraceae

Empetrum sp.

Latin name: *Empetrum nigrum*

Common names: Crowberry, blackberry, curlewberry, mossberry

Habitat: Common in alpine tundra areas; moist areas such as heaths, bogs, and muskegs; moist, rocky slopes (Hultén 1968; Viereck and Little 2007).

Parts used (use): Berry (edible, medicinal).

Seasonality: Berries ripen in August and over-winter on plant.

Potential macrofossils: Berry seeds.

References: Ainana and Zagrebin 2014; Anderson 1939; Andre and Fehr 2001; Andrews 1975; Baldwin 1986; Clark 2012; Garibaldi 1999; Griffin 2001; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Martin 1983; McIntosh 1999; McKennan 1981; Murray et al. 2005; Osgood 1937; Oswalt 1957; Rooth 1971; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995; Wennekens 1985; Young and Hall 1969

Equisetaceae

Equisetum sp.

Latin name: *Equisetum arvense*

Common names: Horsetail, goosefoot

Habitat: Broad range of habitats; common in interior Alaska; moist forests, meadows, and fens; occurs in disturbed areas such as roadsides (Hultén 1968; Johnson et al. 1995).

Parts used (use): Greens (edible).

Seasonality: Gathered in spring when young.

Potential macrofossils: No hard parts.

References: Andre and Fehr 2001; Clark 2012; Garibaldi 1999; Griffin 2001; Jones 2010; Kari 1985; Marles et al. 2000; Oswalt 1957; Uprety et al. 2012; Wennekens 1985

Ericaceae

Arctous spp.

Latin name: *Arctous alpina (*formerly *Arctostaphylos alpina*)

Common names: Alpine bearberry, ptarmigan berry

Habitat: Primarily in alpine and tundra environments; common in dry, windy areas; occasionally in dry, open spruce forests at lower elevations (Hultén 1968; Johnson et al. 1995).

Parts used (use): Berry (edible).

Seasonality: Berries ripen in July and August.

Potential macrofossils: Berry seeds.

References: Anderson 1939; Clark 2012; Garibaldi 1999; Griffin 2001; Halpin 1987; Heller 1953; Jones 2010; Kari 1995; Marles 1984; Marles et al. 2000; Martin 1983; McIntosh 1999; Oswalt 1957; Uprety et al. 2012; Young and Hall 1969

Latin name: *Arctous rubra* (formerly *Arctostaphylos rubra*)

Common names: Red-fruit bearberry, bird's eye, red manzanita

Habitat: Occurs more frequently than *A. alpina*; common at lower elevations in spruce forests; bogs (Viereck and Little 2007).

Parts used (use): Berry (edible).

Seasonality: Berries ripen in July and August.

Potential macrofossils: Berry seeds.

References: Andre and Fehr 2001; Garibaldi 1999; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles et al. 2000

Arctostaphylos sp.

Latin name: *Arctostaphylos uva-ursi*

Common names: Common bearberry, kinnikinnick, mealberry

Habitat: Occurs in forests throughout interior Alaska; common in dry, rocky, sandy areas (Hultén 1968; Viereck and Little 2007).

Parts used (use): Berry and greens (edible).

Seasonality: Berries ripen in August.

Potential macrofossils: Berry seeds.

References: Andre and Fehr 2001; Baldwin 1986; Garibaldi 1999; Gottesfeld 1993; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Murray et al. 2005; Thorton 1999; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995

Ledum spp.

Latin name: *Ledum groenlandicum* (syn. *Rhododendron groenlandicum*)

Common names: Common Labrador tea

Habitat: Common in bogs and heaths; often in dry, rocky places; spruce and birch forests (Hultén 1968; Viereck and Little 2007).

Parts used (use): Leaves (edible, medicinal).

Seasonality: Blooms in June and July; leaves over-winter.

Potential macrofossils: No hard parts.

References: Clavelle 1997; Gottesfeld 1993; Halpin 1987; Jones 2010; Marles 1984; Marles et al. 2000; Murray et al. 2005; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995; Young and Hall 1969

Oxycoccus sp.

Latin name: *Oxycoccus microcarpus* (syn. *Vaccinium oxycoccos and Vaccinium macrocarpon)*

Common names: Bog cranberry, wild cranberry, moss cranberry

Habitat: Occurs in peat bogs; rare (Hultén 1968; Viereck and Little 2007).

Parts used (use): Fruit (edible).

Seasonality: Berries ripen late summer to early fall.

Potential macrofossils: Berry seeds (although they are fragile).

References: Andrews 1975; Baldwin 1986; Clark 2012; Garibaldi 1999; Gottesfeld 1993; Griffin 2001; Halpin 1987; Heller 1953; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Olson 1968; Oswalt 1957; Thorton 1999; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995; Wennekens 1985

Vaccinium spp.

Latin name: *Vaccinium caespitosum*

Common names: Dwarf bilberry, dwarf blueberry, mountain blueberry, dwarf mountain blueberry, low-bush blueberry, black huckleberry

Habitat: Common in moist regions; wet meadows, bogs, and sub-alpine areas (Hultén 1968; Viereck and Little 2007).

Parts used (use): Fruit (edible).

Seasonality: Berries ripen as early as late July into September.

Potential macrofossils: Berry seeds (although they are fragile).

References: Clark 2012; Gottesfeld 1993; Marles et al. 2000; Thorton 1999; Turner 1997; Wennekens 1985

Latin name: *Vaccinium uliginosum*

Common names: Alpine blueberry, bog blueberry, bog bilberry, bog huckleberry, whortleberry, alpine bilberry

Habitat: Common in heaths and bogs in interior Alaska; also found in open forests and tundra environments (Hultén 1968; Viereck and Little 2007).

Parts used (use): Fruit (edible).

Seasonality: Berries ripen in July and August.

Potential macrofossils: Berry seeds (although they are fragile).

References: Ainana and Zagrebin 2014; Andre and Fehr 2001; Anderson 1939; Andrews 1975; Clark 2012; Griffin 2001; Haplin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Martin 1983; McIntosh 1999; McKennan 1981; Murray et al. 2005; Olson 1968; Oswalt 1957; Parlee

et al. 2006; Shinkwin and Case 1984; Thorton 1999; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995

Latin name: *Vaccinium vitis-idaea*

Common names: Mountain cranberry, red whortleberry, low-bush cranberry, lingonberry, mountain cranberry, rock cranberry

Habitat: Broad habitat range; common in spruce and birch forests and bogs; also in dry, rocky alpine and tundra regions (Hultén 1968; Viereck and Little 2007).

Parts used (use): Leaves, fruit (edible).

Seasonality: Berries ripen during the fall after the first frost; berries over-winter.

Potential macrofossils: Berry seeds (although they are fragile).

References: Ainana and Zagrebin 2014; Andre and Fehr 2001; Anderson 1939; Andrews 1975; Baldwin 1986; Clark 2012; Clavelle 1997; Garibaldi 1999; Griffin 2001; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Martin 1983; McIntosh 1999; Murray et al. 2005; Olson 1968; Osgood 1937; Oswalt 1957; Parlee et al. 2006; Shinkwin and Case 1984; Thorton 1999; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995; Viereck 1987; Wennekens 1985; Young and Hall 1969

Fabaceae

Lupinus sp.

Latin name: *Lupinus nootkatensis*

Common names: Nootka lupine

Habitat: Dry slopes, gravel bars, common along the southern coast (Hultén 1968).

Parts used (use): Roots (roots edible, seeds poisonous).

Seasonality: Harvest as a famine food in early spring.

Potential macrofossils: Seeds, roots.

References: Jones 2010; Kari 1995; Wennekens 1985

Leguminosae

Hedysarum sp.

Latin name: *Hedysarum alpinum*

Common names: Wild potato, musoo, Eskimo potato, Alaska carrot, licorice root, sweet vetch, sweet broom, bear root, pea-vine root, alpine hedysarum

Habitat: Variable habitat; moist forests; open woods and meadows; rocky slopes and gravel bars; disturbed areas (Hultén 1968; Johnson et al. 1995).

Parts used(use): Roots (edible).

Seasonality: Roots available year-round; harvested in early spring when the ground thaws or in fall just before freeze-up after the first frost.

Potential macrofossils: Roots.

References: Andrews 1975; Andre and Fehr 2001; Baldwin 1986; Garibaldi 1999; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles et al. 2000; Martin 1983; McIntosh 1999; McKennan 1981; Olson 1968; Shinkwin and Case 1984; Turner 1997; Wein and Freeman 1995

Liliaceae

Allium sp.

Latin name: *Allium schoenoprasum*

Common names: Wild chive, wild onion

Habitat: Moist meadows; grassy slopes; along rivers and shores (Hultén 1968; Johnson et al. 1995).

Parts used (use): Greens (edible).

Seasonality: Harvested in the spring or fall.

Potential macrofossils: No hard parts.

References: Andre and Fehr 2001; Baldwin 1986; Garibaldi 1999; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Wein and Freeman 1995; Wennekens 1985

Onagraceae

Epilobium spp.

Latin name: *Epilobium angustifolium* (syn. *Chamerion angustifolium*)

Common names: Tall fireweed

Habitat: Common in disturbed and recent burn areas; open meadows and forests; along rivers (Hultén 1968; Johnson et al. 1995).

Parts used (use): Leaves, shoots (edible).

Seasonality: Young shoots harvested in the spring; leaves gathered in the fall.

Potential macrofossils: No hard parts, seeds fragile.

References: Anderson 1939; Andre and Fehr 2001; Baldwin 1986; Clark 2012; Garibaldi 1999; Gottesfeld 1993; Griffin 2001; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Martin 1983; McIntosh 1999; Oswalt 1957; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995; Wennekens 1985

Latin name: *Epilobium latifolium* (syn. *Chamerion latifolium*)

Common names: Dwarf fireweed, river beauty

Habitat: Common in disturbed areas such as gravel bars along rivers and streams, scree slopes; floodplains (Hultén 1968; Johnson et al. 1995).

Parts used (use): Leaves, shoots (edible).

Seasonality: Young shoots harvested in the spring; leaves gathered in the fall.

Potential macrofossils: No hard parts, seeds fragile.

References: Ainana and Zagrebin 2014; Baldwin 1986; Clark 2012; Heller 1953; Jones 2010; Martin 1983; Uprety et al. 2012; Wein and Freeman 1995; Young and Hall 1969

Pinaceae

Picea sp.

Latin name: *Picea glauca*

Common names: White spruce

Habitat: Very common; open forests; well-drained, south-facing, gentle slopes; margins of lakes and rivers in sandy soils (Viereck and Little 2007).

Parts used (use): Needles, wood, sap, roots, bark (edible, medicinal, functional).

Seasonality: Year-round.

Potential macrofossils: Woody portions, needles, bud scales.

References: Anderson 1939; Andre and Fehr 2001; Andrews 1975; Baldwin 1986; Clark 2012; Clavelle 1997; Garibaldi 1999; Gottesfeld 1993; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Oswalt 1957; Uprety et al. 2012; Viereck 1987

Latin name: *Picea mariana*

Common names: Black spruce

Habitat: Very common; wet settings; muskegs; cold soils; north-facing slopes; silty terraces; lake margins; wet burn areas (Viereck and Little 2007).

Parts used (use): Needles, wood, sap, roots, bark (edible, medicinal, functional).

Seasonality: Year-round.

Potential macrofossils: Woody portions, needles, bud scales.

References: Andre and Fehr 2001; Andrews 1975; Clark 2012; Garibaldi 1999; Gottesfeld 1993; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995

Polygonaceae

Oxyria sp.

Latin name: *Oxyria digyna*

Common names: Sour grass, mountain sorrel

Habitat: Wet settings of mountain and tundra regions (Hultén 1968).

Parts used (use): Leaves (edible).

Seasonality: Leaves gathered throughout the summer.

Potential macrofossils: No hard parts.

References: Ainana and Zagrebin 2014; Anderson 1939; Clark 2012; Griffin 2001; Heller 1953; Marles et al. 2000; Young and Hall 1969

Polygonum sp.

Latin name: *Polygonum bistorta*

Common names: Pink plume, bistort, mountain bistort

Habitat: Heaths and bogs; meadows (Hultén 1968).

Parts used (use): Leaves, bulbs, roots (edible).

Seasonality: Leaves gathered in early spring and summer.

Potential macrofossils: No hard parts.

References: Ainana and Zagrebin 2014; Griffin 2001; Heller 1953; Jones 2010; Kari 1995; Viereck 1987; Young and Hall 1969

Rumex sp.

Latin name: *Rumex arcticus*

Common names: Sour dock, arctic dock

Habitat: Wet settings; margins of lakes and ponds (Hultén 1968; Johnson et al. 1995).

Parts used (use): Greens (edible).

Seasonality: Gathered as early as May and June; present throughout the summer.

Potential macrofossils: No hard parts.

References: Ainana and Zagrebin 2014; Anderson 1939; Garibaldi 1999; Griffin 2001; Heller 1953; Jones 2010; Kari 1985, 1995; McIntosh 1999; Oswalt 1957; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995; Wennekens 1985; Young and Hall 1969

Polypodiaceae

Athyrium sp.

Latin name: *Athyrium filix-femina*

Common names: lady fern

Habitat: Scattered in interior Alaska; moist forests; thickets along streams; occasionally found in bogs (Hultén 1968; Johnson et al. 1995).

Parts used (use): Greens (edible).

Seasonality: Gathered in spring and fall; present throughout the summer.

Potential macrofossils: No hard parts.

References: Garibaldi 1999; Gottesfeld 1993; Kari 1995; Uprety et al. 2012; Wennekens 1985

Dryopteris sp.

Latin name: *Dryopteris expansa*

Common names: spiny wood fern

Habitat: Common in moist areas; openings in forests and thickets; occasionally found in bogs (Hultén 1968; Johnson et al. 1995).

Parts used (use): Roots (edible).

Seasonality: Gathered in spring and fall; present throughout the summer.

Potential macrofossils: Roots.

References: Garibaldi 1999; Griffin 2001; Kari 1995; Marles et al. 2000; Osgood 1937; Uprety et al. 2012; Viereck 1987

Rosaceae

Amelanchier sp.

Latin name: *Amelanchier alnifolia*

Common names: Serviceberry, Saskatoon berry, common Saskatoon

Habitat: Rare in interior Alaska; well-drained, south-facing slopes and bluffs (Hultén 1968; Viereck and Little 2007).

Parts used (use): Berry (edible).

Seasonality: Berries ripen in July and August.

Potential macrofossils: Woody portions, berry seeds.

References: Baldwin 1986; Clavelle 1997; Gottesfeld 1993; Kari 1995; Marles 1984; Marles et al. 2000; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995

Fragaria sp.

Latin name: *Fragaria virginiana*

Common names: Blue-leaf strawberry, wild strawberry, Virginia strawberry

Habitat: Dry to moist areas; open woodlands and borders of forests (Hultén 1968; Johnson et al. 1995).

Parts used (use): Leaves, berry (edible).

Seasonality: Berries ripen in May through early July.

Potential macrofossils: Berry seeds.

References: Gottesfeld 1993; Holloway and Alexander 1990; Marles 1984; Marles et al. 2000; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Viereck 1987

Potentilla sp.

Latin name: *Potentilla anserina* (syn. *Potentilla egedii*, *Potentilla pacifica*, and *Argentina anserina*)

Common names: Common silverweed, cinquefoil, Indian sweet potato, pacific silverweed

Habitat: Moist areas such as meadows, lakeshores, and riverbanks (Hultén 1968).

Parts used (use): Roots (edible).

Seasonality: Gathered in fall.

Potential macrofossils: Roots, seeds.

References: Baldwin 1986; Turner 1997; Uprety et al. 2012; Wennekens 1985

Latin name: *Potentilla fruticosa* (syn. *Dasiphora fruticose* and *Pentaphylloides floribunda*)

Common names: Tundra rose, shrubby cinquefoil

Habitat: Common in a range of habitats; wet and dry areas; open woodlands; heaths; muskegs; scree slopes (Hultén 1968).

Parts used (use): Roots (edible).

Seasonality: Gathered in fall.

Potential macrofossils: Roots, seeds.

References: Anderson 1939; Garibaldi 1999; Kari 1985, 1995; Marles et al. 2000; Uprety et al. 2012; Wennekens 1985

Rosa sp.

Latin name: *Rosa acicularis*

Common names: Prickly rose, wild rose, rosehips

Habitat: Common in thickets and along roads; forests; bogs; heaths (Hultén 1968; Viereck and Little 2007).

Parts used (use): Fruit (edible).

Seasonality: Fruit ripens in August; fruit over-winters on the plant.

Potential macrofossils: Fruit seeds, wood portions, spines/thorns.

References: Andre and Fehr 2001; Andrews 1975; Baldwin 1986; Clavelle 1997; Garibaldi 1999; Gottesfeld 1993; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Martin 1983; McKennan 1981; Murray et al. 2005; Oswalt 1957; Rooth 1971; Shinkwin and Case 1984; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995

Rubus spp.

Latin name: *Rubus arcticus*

Common names: Nagoonberry, lagoonberry, dewberry, dwarf raspberry, trailing raspberry, wineberry, raspberry

Habitat: Common in moist meadows, woods, and thickets (Hultén 1968; Johnson et al. 1995).

Parts used (use): Berry (edible).

Seasonality: Berries ripen in July and August.

Potential macrofossils: Berry seeds.

References: Anderson 1939; Clark 2012; Griffin 2001; Halpin 1987; Heller 1953; Jones 2010; Kari 1985, 1995; Marles et al. 2000; Oswalt 1957; Thorton 1999; Wennekens 1985; Young and Hall 1969

Latin name: *Rubus chamaemorus*

Common names: Cloudberry, salmonberry, baked-apple berry, yellow berry

Habitat: Common in peat bogs throughout the boreal forest (Hultén 1968; Johnson et al. 1995).

Parts used (use): Berry (edible).

Seasonality: Berries ripen in July.

Potential macrofossils: Berry seeds.

References: Ainana and Zagrebin 2014; Anderson 1939; Andre and Fehr 2001; Baldwin 1986; Clark 2012; Garibaldi 1999; Griffin 2001; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Martin 1983; McIntosh 1999; Murray et al. 2005; Oswalt 1957; Parlee et al. 2006; Thorton 1999; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995; Wennekens 1985; Young and Hall 1969

Latin name: *Rubus idaeus*

Common names: Wild raspberry, American red raspberry

Habitat: Common in forest openings and border; commonly forms thickets along riverbanks; sandy and gravelly floodplains; terraces; alluvial fans (Hultén 1968; Viereck and Little 2007).

Parts used (use): Berry (edible).

Seasonality: Ripens in July and August.

Potential macrofossils: Berry seeds.

References: Andrews 1975; Baldwin 1986; Clavelle 1997; Gottesfeld 1993; Halpin 1987; Heller 1953; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Martin 1983; McKennan 1981; Murray et al. 2005; Osgood 1937; Rooth 1971; Shinkwin and Case 1984; Thorton 1999; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995

Salicaceae

Populus sp.

Latin name: *Populus balsamifera*

Common names: Balsam poplar, black cottonwood, black poplar

Habitat: Common and widespread over alluvial flats and river valleys in interior Alaska (Hultén 1968).

Parts used (use): Bark, wood, buds (edible, medicinal, functional).

Seasonality: Year-round; cambium gathered in spring.

Potential macrofossils: Woody portions, buds and bud scales.

References: Andre and Fehr 2001; Andrews 1975; Baldwin 1986; Clark 2012; Garibaldi 1999; Gottesfeld 1993; Halpin 1987; Holloway and Alexander 1990; Jones 2010; Kari 1985, 1995; Marles et al. 2000; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995; Wennekens 1985

Latin name: *Populus tremuloides*

Common names: Trembling aspen, quaking aspen

Habitat: Open woods; recently burned slopes; common in dense, pure stands throughout the interior; well-drained, south-facing slopes; well-drained locations (Hultén 1968).

Parts used (use): Bark, wood, buds (edible, medicinal, functional).

Seasonality: Year-round; cambium gathered in spring.

Potential macrofossils: Woody portions, buds and bud scales.

References: Andrews 1975; Clavelle 1997; Garibaldi 1999; Gottesfeld 1993; Holloway and Alexander 1990; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995

Salix spp.

Latin name: *Salix* spp. (many used, generalized to genus level)

Common names: Willow

Habitat: Variable depending on species (Hultén 1968).

Parts used (use): Leaves, buds, wood (edible, medicinal, functional).

Seasonality: Year-round use.

Potential macrofossils: Woody portions, buds and bud scales.

References: Ainana and Zagrebin 2014; Anderson 1939; Andrews 1975; Andre and Fehr 2001; Clark 2012; Clavelle 1997; Garibaldi 1999; Gottesfeld 1993; Halpin 1987; Holloway and Alexander 1990; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Oswalt 1957; Shinkwin and Case 1984; Uprety et al. 2012; Viereck 1987; Wein and Freeman 1995; Wennekens 1985; Young and Hall 1969

Saxifragaxceae

Ribes spp.

Latin name: *Ribes glandulosum*

Common names: Wild red currant, skunk currant

Habitat: Occurs in lowland locations; woods; rocky slopes (Hultén 1968).

Parts used (use): Fruit (edible).

Seasonality: Fruits ripen in July.

Potential macrofossils: Berry seeds (although they are fragile).

References: Andrews 1975; Clark 2012; Kari 1995; Marles 1984; Marles et al. 2000; McKennan 1981; Murray et al. 2005; Osgood 1937; Rooth 1971; Shinkwin and Case 1984; Uprety et al. 2012

Latin name: *Ribes hudsonianum*

Common names: Northern black currant

Habitat: Occurs along streams; moist woods (Hultén 1968).

Parts used (use): Fruit (edible).

Seasonality: Fruits ripen in July and August.

Potential macrofossils: Berry seeds (although they are fragile).

References: Garibaldi 1999; Holloway and Alexander 1990; Kari 1985, 1995; Marles 1984; Marles et al. 2000; Murray et al. 2005; Osgood 1937; Shinkwin and Case 1984; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995

Latin name: *Ribes lacustre*

Common names: Swamp gooseberry, swamp currant, prickly currant

Habitat: Occurs along streams; moist woods (Hultén 1968).

Parts used (use): Fruit (edible).

Seasonality: Fruits ripen in August.

Potential macrofossils: Berry seeds (although they are fragile).

References: Marles et al. 2000; Thorton 1999; Turner 1997; Uprety et al. 2012; Wein and Freeman 1995

Latin name: *Ribes triste*

Common names: Northern red currant, red swamp currant, wild red currant

Habitat: In moist areas along streams and in meadows; spruce forests (Hultén 1968).

Parts used (use): Fruit (edible).

Seasonality: Fruits ripen in July.

Potential macrofossils: Berry seeds (although they are fragile).

References: Anderson 1939; Andre and Fehr 2001; Andrews 1975; Baldwin 1986; Garibaldi 1999; Gottesfeld 1993; Heller 1953; Jones 2010; Kari 1985, 1995; Marles 1984; Uprety et al. 2012; Wein and Freeman 1995

Typhaceae

Typha sp.

Latin name: *Typha latifolia*

Common names: Cat-tail

Habitat: Common in marshes and shallow water; ponds; moist ditches (Hultén 1968).

Parts used (use): Rhizomes, greens, and shoots (edible).

Seasonality: Gathered in early summer.

Potential macrofossils: Possibly roots.

References: Clavelle 1997; Heller 1953; Holloway and Alexander 1990; Kari 1985; Marles 1984; Marles et al. 2000; Turner 1997; Uprety et al. 2012

Umbelliferae

Heracleum sp.

Latin name: *Heracleum lanatum*

Common names: Cow-parsnip, wild celery

Habitat: Often in alpine settings; woods; meadows; streambanks (Hultén 1968).

Parts used (use): Greens, stalks (edible).

Seasonality: Gathered in early spring.

Potential macrofossils: No hard parts.

References: Marles 1984; Viereck 1987

Faunal Resources

Rangifer sp.

Latin name: *Rangifer tarandus*

Common names: Caribou

Habitat: Uplands: open tundra spring/summer, forests in fall/winter; lowland spruce forest; upland spruce forests; moist tundra; alpine (Alaska Department of Fish and Game 2015)

Parts used (use): Skins were used for clothing, shelter, blankets, and footwear; meat was eaten fresh or dired and stored in aches; sinew was used as line; antler and bone was used to manufacture tools; organs were consumed

Seasonality: Spring (May) and fall (September-November migrations; more important because caribou were fat after a summer of feasting

References: McKennan 1959; Hosley 1981; Andrews 1975; Halpin 1987; Haynes and Simeone 2007

Alces sp.

Latin name: *Alces alces*

Common names: Moose

Habitat: Broad range, but thrive of transitional vegetation; generally restricted to valleys and lowlands with plentiful browse; bottomland spruce-poplar forest; lowland spruce forest; low brush, muskey, bog; upland spruce forests; moist tundra (ADF&G 2015)

Parts used (use): Skins used for clothing, primarily for summer or indoor garments, also for tents, dog harnesses, and sashes for carrying children, also, occasionally for making boats; sinew was used as line; bone and antler was used for tools; meat and organs were consumed

Seasonality: Year-round, whenever encountered

References: Andrews 1975; McKennan 1959, 1981; Hosley 1981; Halpin 1987; Haynes and Simeone 2007; Shinkwin and Case 1984

Ovis sp.

Latin name: *Ovis dalli*

Common names: Dall sheep

Habitat: Alpine regions, feeding on grass, willow, dryas, and lichens; moist tundra; alpine (ADF&G 2015)

Parts used (use): Sheep meat was highly sought after; skins used for bedding; horns and bones used for tools and utensils

Seasonality: Late summer prior to fall caribou hunts

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Ursus sp.

Latin name: *Ursus americanus*

Common names: Black bear

Habitat: Found throughout Tanana River valley; lowland spruce forests; low brush, muskeg, bog; upland spruce forests; moist tundra (ADF&G 2015)

Parts used (use): Black bear meat was preferred to grizzly; bear fat often mixed with berries for storage; bone considered highly durable and was desired for tools

Seasonality: Taken when encountered

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007; Shinkwin and Case 1984

Latin name: *Ursus arctos*

Common names: Grizzly bear

Habitat: Found throughout Tanana River valley; more common at higher elevations; upland spruce forests; moist tundra (ADF&G 2015)

Parts used (use): Hides were used as bedding; bone was considered incredibly durable and was highly desired for tools; bear fat often mixed with berries for storage

Seasonality: Taken when encountered

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Lepus sp.

Latin name: *Lepus americanus*

Common names: Snowshoe hare

Habitat: Widely variable, found in mixed spruce forests, wooded swamps, and brushy areas; bottomland spruce-poplar forest; lowland spruce forest; upland spruce forests; moist tundra (ADF&G 2015)

Parts used (use): Furs were used for blankets, caps, and as insulation in boots and mittens; became major player in subsistence in times of resource scarcity

Seasonality: Snared, taken when encountered; also, more during the winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Tetraonidae spp.

Latin name: *Canachites canadensi; Pedioecetes phasianellus; Dendragapus canadensis; Tympanuchus phasianellus; Bonasa umbellus; Lagopus* sp.

Common names: Grouse and ptarmigan species

Habitat: Bottomland spruce-poplar forest; lowland spruce forest; low brush, muskeg, bog; upland spruce forests (ADF&G 2015)

Parts used (use): Meat

Seasonality: Taken when encountered; often during the fall, winter, and spring

References: Andrews 1975; McKennan 1959, 1981; Halpin 1987

Spermophilus sp.

Latin name: *Spermophilus undulatus*

Common names: Ground squirrel

Habitat: Higher altitudes, hills, less common in lowlands; bottomland spruce-poplar forest (ADF&G 2015)

Parts used (use): Meat

Seasonality: Snared, taken when encountered

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981

Erethizon sp.

Latin name: *Erethizon dorsatum*

Common names: Porcupine

Habitat: Found throughout most of the forested areas of the state (ADF&G 2015)

Parts used (use): Meat

Seasonality: Taken when encountered year-round

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Castor sp.

Latin name: *Castor canadensis*

Common names: Beaver

Habitat: Bottomland spruce-poplar forest; low brush, muskeg, bog (ADF&G 2015)

Parts used (use): Meat; pelt

Seasonality: Taken when encountered year-round

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Fur-Bearers

Ondatra sp.

Latin name: *Ondatra zibethicus*

Common names: Muskrat

Habitat: Low brush, muskeg, bog (ADF&G 2015)

Parts used (use): Pelt

Seasonality: Snared, taken when encountered; often during winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Lutra sp.

Latin name: *Lutra canadensis*

Common names: Land otter; river otter

Habitat: Bottomland spruce-poplar forest; low brush, muskeg, bog (ADF&G 2015)

Parts used (use): Pelt

Seasonality: Snared, taken when encountered; often during winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Mustela sp.

Latin name: *Mustela americanus*

Common names: American marten

Habitat: Higher altitudes, hills, less common in lowlands; bottomland spruce-poplar forest; upland spruce forests (ADF&G 2015)

Parts used (use): Pelt

Seasonality: Snared, taken when encountered; often during winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Gulo sp.

Latin name: *Gulo gulo*

Common names: Wolverine

Habitat: Bottomland spruce-poplar forest; lowland spruce forest; low brush, muskeg, bog; upland spruce forests (ADF&G 2015)

Parts used (use): Pelt

Seasonality: Snared, taken when encountered; often during winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987

Lynx sp.

Latin name: *Lynx canadensis*

Common names: Lynx

Habitat: Lowland spruce forest (ADF&G 2015)

Parts used (use): Pelt

Seasonality: Snared, taken when encountered; often during winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987

Vulpes sp.

Latin name: *Vulpes vulpes*

Common names: Red fox

Habitat: Lowland spruce forest; low brush, muskeg, bog; upland spruce forests; moist tundra (ADF&G 2015)

Parts used (use): Pelt

Seasonality: Snared, taken when encountered; often during winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Latin name: *Marmota* spp.

Common names: Marmot

Habitat: Higher altitudes, hills, less common in lowlands (ADF&G 2015)

Parts used (use): Pelt

Seasonality: Snared, taken when encountered; often during winter months

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981

Migratory Waterfowl

Melanitta sp.

Latin name: *Melanitta deglandi*

Common names: White-Winged Scoter

Habitat: Low brush, muskeg, bog (Andrews 1975)

Parts used (use): Meat

Seasonality: Primarily taken at fish camps during summer and spring

References: Andrews 1975; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Branta sp.

Latin name: *Branta canadensis*

Common names: Canada goose

Habitat: Low brush, muskeg, bog (ADF&G 2015)

Parts used (use): Meat

Seasonality: Primarily taken at fish camps during summer and spring

References: Andrews 1975; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007

Latin name: *Branta bernicla*

Common names: Brant

Habitat: Low brush, muskeg, bog (Andrews 1975)

Parts used (use): Meat

Seasonality: Primarily taken at fish camps during summer and spring

References: Andrews 1975; McKennan 1959, 1981; Halpin 1987

Chen sp.

Latin name: *Chen caerulescens* (syn. *Anser caerulescens*)

Common names: Snow goose

Habitat: Low grassy tundra with flat basins near lakes, rivers, and flood plains (Meyers et al. 2015)

Parts used (use): Meat

Seasonality: Primarily spring and fall

References: Halpin 1987

Bucephala sp.

Latin name: *Bucephala clangula*

Common names: Common Goldeneye

Habitat: Lakes and rivers surrounded by mature forests; clear water and little emergent vegetation (Myers et al. 2015)

Parts used (use): Meat

Seasonality: Primarily spring and fall

References: Halpin 1987; Haynes and Simeone 2007

Aythya sp.

Latin name: *Aythya marila*

Common names: Greater Scaup

Habitat: Wetland habitats, ponds, wetland margins, lakes, rivers, wetland meadows or grassland areas near ponds (Meyers et al. 2015).

Parts used (use): Meat

Seasonality: Primarily spring and fall

References: Halpin 1987; Haynes and Simeone 2007

Latin name: *Aythya affinis*

Common names: Lesser Scaup

Habitat: Wetland habitats, ponds, wetland margins, lakes, rivers, wetland meadows or grassland areas near ponds (Myers et al. 2015).

Parts used (use): Meat

Seasonality: Primarily spring and fall

References: Halpin 1987; Haynes and Simeone 2007

Cygnus spp.

Latin name: *Cygnus* spp.

Common names: Swan

Habitat: Marshes, ponds, lakes (ADG&G 2015)

Parts used (use): Meat

Seasonality: Primarily spring and fall

References: Halpin 1987; Haynes and Simeone 2007

Grus sp.

Latin name: *Grus canadensis*

Common names: Sandhill crange

Habitat: Grassland, bogs, marshes, marshy edges of lakes and rivers (ADG&G 2015)

Parts used (use): Meat

Seasonality: Primarily spring and fall

References: Halpin 1987

Fish

Onchorynchus spp.

Latin name: *Onchorynchus tschawyrscha*

Common names: King salmon, chinook salmon

Habitat: Anadromous; Up the Tanana as far as the Goodpaster River

Parts used (use): Meat; sometimes preserved for future use

Seasonality: First week of July until the first week of August

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007; Shinkwin and Case 1984

Latin name: *Onchorynchus keta*

Common names: Dog salmon, chum salmon

Habitat: Anadromous; Up the Tanana as far as the Goodpaster River

Parts used (use): Meat; sometimes preserved for future use

Seasonality: Fall run, late August until November

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Shinkwin and Case 1984

Latin name: *Onchorynchus kisutch*

Common names: Silver salmon, coho salmon

Habitat: Anadromous; Up the Tanana as far as the Goodpaster River

Parts used (use): Meat; sometimes preserved for future use

Seasonality: Fall run, late August until November

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Halpin 1987; Haynes and Simeone 2007; Shinkwin and Case 1984

Thymallus sp.

Latin name: *Thymallus arcticus*

Common names: Grayling

Habitat: Riverine/lacustrine; high-elevation, middle to large, cold, clear, freshwater lakes and rivers (Myers et al. 2015).

Parts used (use): Meat; sometimes preserved for future use

Seasonality: Spring, summer, fall

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Haynes and Simeone 2007

Coregonus sp.

Latin name: *Coregonus* sp.

Common names: Whitefish

Habitat: Riverine/lacustrine; primarily found in large, cold, freshwater lakes and their drainage basins (Myers et al. 2015)

Parts used (use): Meat; sometimes preserved for future use

Seasonality: Spring, summer, fall

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Haynes and Simeone 2007; Shinkwin and Case 1984

Lota sp.

Latin name: *Lota lota*

Common names: Burbot

Habitat: Riverine/lacustrine; found in deep temperate lake bottoms and slow moving cold river bottoms; primarily freshwater (Myers et al. 2015)

Parts used (use): Meat; sometimes preserved for future use

Seasonality: Fall

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Haynes and Simeone 2007; Shinkwin and Case 1984

Esox sp.

Latin name: *Esox lucius*

Common names: American pike; great northern pike; jackfish

Habitat: Riverine/lacustrine; variety of freshwater environments, cold deep lakes, warm shallow ponds, muddy rivers (Myers et al. 2015).

Parts used (use): Meat; sometimes preserved for future use

Seasonality: Spring, summer, fall

References: Andrews 1975; Hosley 1981; McKennan 1959, 1981; Haynes and Simeone 2007

Slavelinus sp.

Latin name: *Salvelinus namaycush*

Common names: Lake trout

Habitat: Lacustrine, cold-water species (Myers et al. 2015)

Parts used (use): Meat; sometimes preserved for future use

Seasonality: Spring, summer, fall

References: Haynes and Simeone 2007

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Appendix C
Control Samples

Table C.1 Control Samples from the Upward Sun River Site.					
Provenience	**Sample Number**	**Depth (cm BS)**	**Soil Horizon**	**Sample Size (ml)**	**Macrofossils (n)**
Block Z, North Wall	1	5-15	A/B	150	Carbonized twigs (5); bark (4, 3 carbonized); uncarbonized leaf bud scale (1)
	2	15-25	B/C	150	Vegetative bits (2)
	3	25-32	B/C	150	Carbonized bark (5)
	4	32-35	C	50	Uncarbonized bud scale (1)
	5	35-40	Bwb	150	Carbonized bark (2)
	6	40-45	C	100	Carbonized bark (1)
	7	50-60	C	100	Carbonized bark (1)
	8	60-70	C	150	Nothing
	9	70-80	C	150	Nothing
	10	80-90	C	150	Nothing
	11a	90	C	100	Nothing
	11b	90-95	Ab	100	Nothing
	12	95	C	100	Nothing
	13	110	Ab	150	Nothing
	19	110-115	Ab	150	Nothing
	20	125-140	C	100	Nothing
	22	140-143	C	100	Nothing
	23	143-150	Sand lens	50	Nothing
	24	150-153	C	50	Nothing
	25	163-175	Sand lens	50	Nothing
	27	270-280	C	150	Nothing
Block L, N499E502 NE ¼	1	160-170	C/sand lens	500	Nothing
	3	180-190	C	500	Nothing
	5	200-210	C	500	Nothing
	6	210-220	C	500	Nothing
	7	220-230	C	500	Nothing
	8	230-240	C	500	Nothing
	9	240-250	C	500	Nothing
Block L N499E501 NE ¼	2	170-180	C/sand lens	500	Nothing
Block M N498E503 NE ¼	4	190-200	C	500	Nothing
	11	260-270	C	500	Nothing
Block M N499E503 NE ¼	10	250-260	C	250	Nothing
	12	270-280	C	250	Nothing

Appendix D
Uncarbonized Macroremains

Table D.1 Uncarbonized Floral Remains from the Upward Sun River Site.								
	Component 1		Component 3					
Taxon	**2010-2**	**2014-5**	**2010-5**	**2011-6A**	**2013-9**	**2013-11**	**2013-20**	**2014-6**
Betula sp.	0	0	0	2	0	1	0	1
Betula cf. *glandulosa*	0	0	1	0	2	0	1	0
Betula cf. *neoalaskana*	0	1	0	0	3	1	1	0
Picea needle	0	0	1	0	2	0	0	0
Unidentified seeds	0	0	3	0	0	0	0	0
Buds/bud scales	0	4	28	3	70	2	9	19
Density (Total N)	0	5	33	5	77	3	11	20
Total Sed. Volume (L)	1.815	2.75	16.28	3.29	3.6	3.35	2.1	3.65